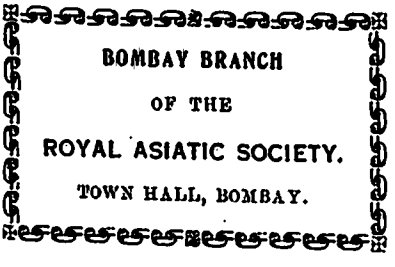
Agricultural Operations, in India, review of.

1927-28 & 1928-29





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Review of Agricultural Operations in India

1927-28 & 1928-29

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HIS EXCELLENCY THE VICEROY, LADY IRWIN AND THE GAZETTED STAFF OF THE AGRICULTURAL RESEARCH INSTITUTE, PUSA.
(4th January, 1929.)

Review of Agricultural Operations in India 1927-28

CHAPTER I.

AGRICULTURAL CONDITIONS OF THE YEAR.

The monsoon of 1927 was, on the whole, normal and the rainfall was well distributed except in North Gujarat, Kathiawar, South Sind, Orissa and South-West Punjab. Abnormally heavy precipitations were recorded in the last week of July on the West Coast from Broach to South Sind, and much of North Gujarat was flooded. Though all standing crops were destroyed, the damage done to agricultural land and live stock was remarkably small; and, thanks to prompt relief measures, the resowing of *kharif* (autumn) crops and the substitution of *rabi* (spring) for *kharif* crops became general. A similar calamity occurred in August in Orissa, and the winter paddy crop was irretrievably damaged, but the arrangements for seed distribution made by the Agricultural Department placed the cultivators in a position to grow catch crops. The Nellore District in Madras suffered heavily from the devastating fury of the cyclonic storm which heralded the arrival of the north-east monsoon. The season, though characterized by such calamities, can, taking India as a whole, be described as fair; all the important crops, except wheat, linseed and mustard, gave moderately good outturns. The prolonged damp cloudy weather which prevailed over large parts of the country in January and February, brought about a heavy incidence of rust in wheat, and the average yield per acre was the lowest for the last decennium.

The general condition of the agricultural population, depending as it does primarily on the course of the monsoon, was fairly good. Although prices of necessities of life were somewhat easier than in the previous year, the wages of agricultural labour remained generally unchanged.

Rinderpest was less prevalent in some provinces but the total mortality from contagious diseases among cattle stood at a high figure. Except in districts which suffered from floods, the fodder supply was normal.

CHAPTER II.

ECONOMIC WORK ON CROPS.

The Agricultural Departments in India have, during the last 23 years, devoted particular attention to the distribution of improved varieties of the principal staple crops of the country. Most of them have been obtained by the usual methods of selection from the mixtures previously grown. While the use of mixed seed consisting of different varieties which varied with respect to quality and yield had resulted both in low yields and lack of uniformity in the produce, the pure lines isolated now permit larger crops of superior quality to be raised under the same treatment, and yield a higher economic return, more especially when their use is accompanied by manuring and improved cultural methods. When difficulty in getting types, suitable both from the point of yield and the quality of the produce, by pure line selection has been experienced, either acclimatization or hybridization has been resorted to, and we have now as a result many improved strains of wheat, cotton, rice, sugarcane and other crops under cultivation. The success of this line of work was immediate. The improvement effected was one which appealed to the cultivator as its adoption did not involve any material increase in his expenditure, for the premium charged for the improved seed has been insignificant. The area reported to be under improved varieties in the year under review has almost doubled since 1923-24, as will be gathered from the statement below.

Area in acres under improved varieties.

Crop	1923-24	1927-28
Cotton	2,348,882	3,272,638
Wheat	1,398,885	3,517,552
Rice	603,603	953,236
Jute	210,262	989,105
Sugarcane	50,604	268,688
Other crops	467,146	964,037
TOTAL	5,079,382	9,965,256

If Rs. 12 per acre—a conservative figure—be taken as the average additional profit made from the adoption of these varieties, it is estimated that the annual value of the agricultural crops of the country has been enhanced by nearly 12 crores of rupees. But, as remarked by the Royal Commission on Agriculture in India, considerable as have been the achievements of the Agricultural Departments in introducing improved varieties of crops, there is still a vast field for further work in this direction. Departments of Agriculture have as yet but touched the fringe of this great problem.

I. Rice.

Among all the crops grown in India, rice stands an easy first in importance. On an average it occupies 35 per cent. of the total cultivated area, and it is the staple food of most of the people of this country. Being mainly a monsoon crop, its area and yield are affected, to a larger extent than those of any other crop, by the amount and distribution of the rainfall. Owing to the somewhat erratic course of the monsoon over Bengal, the area of 78,113,000 acres reported as having been sown during the year was 2 per cent. less than in 1926-27. The estimated outturn of 28,176,000 tons of cleaned rice represented a reduction of 6 per cent. in total yield and of 26 lb. per acre. In addition, 958,000 tons of rice are believed to have been harvested from 2,663,000 acres for which no forecasts are prepared. Besides meeting the requirements of internal consumption, this huge crop enables India to maintain the position of the largest exporter of rice in the world. The 2,200,000 tons valued at Rs. 34,01 lakhs exported during the year formed only 8 per cent. of the total estimated production. Of the important rice-growing provinces, Burma alone has a large exportable surplus; besides contributing 86 per cent. of the foreign exports, she supplied 904,000 tons of rice and 184,000 tons of paddy to India proper. A feature of the rice trade of the year was the unprecedentedly large imports of foreign rices during the last five months of the year; 78 per cent. of the 68,954 tons received went to Madras where there was a partial failure of crops owing to in sufficient rains and damage wrought by cyclones.

In BENGAL, rice occupies nearly 19 million acres or 71 per cent. of the cropped area of the province and 25 per cent. of the total acreage under the crop in India. Rice investigations therefore figure prominently in the programme of the plant-breeders of the province, who have succeeded in isolating types which give large yields when grown under conditions to which they are suited. In Indrasail and Dudshar the department has transplanted *amans* (winter rices) which are suited for the heavy and light soils, respectively, of Northern and Eastern Bengal. The variety which is doing best in West Bengal is Jhingasail. The broadcast *aus* (autumn rice) group is represented by Kataktara which yields heavy crops on fertile land, and by a very fine rice called Charnak which is recommended for lighter soils. During the year under report, they were estimated to have been grown on an area of 133,000 acres. The problem of producing early-maturing strains of autumn and winter rices for double-cropped lands in West Bengal, where the early cessation of the rains is a frequent occurrence, is, it is believed, nearing solution. Some of the *aus* crosses are as heavy yielders as Kataktara and ripen a fortnight earlier. Hybridization between early and late *amans* has produced strains which give about 20 cwt. of grain per acre in the first week of November. Selection work on the fine Balam rice, which thrives well particularly round the coast line of Bengal, has yielded a strain (Chingribhusi No. 5) which has, over a period of three years, given on an average 20 per cent. more grain than the ordinary local seed. All these promising new types are being multiplied for large scale trials on cultivators' fields.

The Paddy-breeding Specialist in MADRAS has a rice-breeding station at Coimbatore and three sub-stations in the principal rice-growing tracts. The fifteen types under distribution are G. E. B. 24 and Co. 1—7 from Coimbatore and A. 1—7 from Aduturai. The selections from Aduturai have created such a good impression in the Tanjore Delta that the demand for seed was three times greater than the amount available for distribution. The sub-stations at Maruteru on the East Coast and at Pattambi on the West Coast are comparatively new and the breeding work thereon has not got

beyond the initial stage. Two of the lines isolated by mass selection at Maruteru have, however, done so well on cultivators' fields that indents for a large quantity of seed have been received for the next season. Good progress is reported to have been made at Coimbatore in breeding in resistance to *Blast* disease.

Although BURMA carries only 14 per cent. of the total acreage under rice, she has 50 per cent. of the crop available for export and contributes 86 per cent. of foreign exports. From the earliest days of the local Agricultural Department, the policy has therefore been to improve the quality of their rices with a view to meeting the requirements of foreign markets. With this aim in view, the department has by selection tried to eliminate the defects which are so characteristic of Burma rice. The common defects are the presence of the red grain of wild rices, the lack of uniformity in the size of the grains, excessive breakage at the time of milling and the presence of awns. The department has succeeded in selecting ten types which have uniform white grain and yield in the mill a higher percentage of whole high quality rice than the local varieties commonly grown. These selections are reported to be popular both with the growers and the millers. The millers pay a premium of from Rs. 5 to Rs. 20 per hundred baskets (4,600 lb.) for these improved strains, and the cultivators are said to make an extra profit of Rs. 10 per acre by growing them. The area under these improved varieties has increased from 73,000 to 319,000 acres since 1921-22. Though this area is less than 3 per cent. of the total area under rice in Burma, the leaven is gradually working, and slowly but surely the standard of Burma rice is being raised. While active steps are being taken to make available larger quantities of seed of the types in demand, the search for strains which will fit into the special conditions of different tracts is being continued at the Mandalay, Hmawbi, Myaungmya and Akyab farms. Some of the Akyab selections have been favourably commented upon by trade experts to whom samples were supplied for examination. They consider that their quality is sufficiently high to command a good European market, and that it is unnecessary to resort to exotic varieties to improve the Arakan trade. At

Myaungmya two white-grained strains of deep-water paddies have been selected from a sample containing 90 per cent. of red grain. These strains can be grown successfully in 12 feet of water. Trials with Ammophos at 30 centres in the Southern Circle have shown that the promising results obtained with this manure on the Hmawbi station can be applied to all the districts in the Circle with the possible exception of the richer soils in North Tharrawaddy and North Pegu.

The superiority of Sabour Dahia when grown on poor soils remains unchallenged in BIHAR AND ORISSA. Originally selected for South Bhagalpur, it has proved generally suitable as an early winter paddy for many parts of the province. It combines a heavy yield with earliness, and has established a good reputation as a table rice. Even in Sambalpur which has a high reputation for good quality rices, Dahia commands a premium of 15 per cent. over local paddies. The three selections, representing medium early, medium late and late rices, made at Cuttack have become popular in parts of Orissa on account of their high yield. In Chota Nagpur, a new variety called Rais 37 has been obtained at Kanke, which has proved very suitable for cultivation in terraced fields which dry up too soon for Dahia. The Latisail of Assam is doing well in Chota Nagpur; it is also making headway in parts of North-East Bihar. Ammophos, containing 20 per cent. each of ammonia and phosphoric acid, has proved an extraordinarily effective manure for paddy throughout South Bihar; 37 tons of this fertilizer were sold through the department in 1928. In Orissa the best results are obtained by green-manuring, and this is now becoming a standard practice in villages near Government farms. On the poor soils of the Chota Nagpur plateau, increases of yield ranging from 22 to 39 per cent. have been obtained by applying ammonium sulphate at the rate of 1½ cwt. per acre.

Latisail has been found to suit the average soil of ASSAM better than any other variety tried: it has a short growing period. The demand for bonemeal as a manure for rice is extending in the Khasi and Jaintia Hills; the immediate return is economic and the residual effect of this manure lasts up to the fourth year.

Kolamba rice No. 42 isolated at Karjat in the BOMBAY Presidency has spread over 40,000 acres in the North Konkan. Another selection known as Kolamba No. 79 has been found particularly suitable for high-lying areas in the Thana District. The rice crop of Sind is being dealt with at Larkana where improved types of Kangani and Sugdasi rices are now available for distribution. The indications are that dressings of ammonium sulphate up to 300 lb. per acre can be applied at a profit in the North Konkan. On the laterite soils of the South Konkan and North Kanara, bone-meal is more economical than ammonium sulphate.

Of the various varieties of rice under distribution in the MYSORE STATE, G. E. B. 24 from the Coimbatore Station is the most popular. It has been ascertained on the Naggenhalli farm that in the canal areas increased yields of from 40 to 50 per cent. of rice can be obtained by manuring the crop with a green manure in combination with sulphate of ammonia and superphosphate. The net acreage profit is largest when 60 lb. of ammonia and 320 lb. of superphosphate are applied. In the TRAVANCORE STATE, the results obtained from manurial experiments indicate that for rice it is not economical to spend more than Rs. 15-20 per acre on manures.

II. Wheat.

Wheat is the main food staple of the people of Upper India. The acreage under this crop in India as a whole is second only to that of rice, and is on an average 10 per cent. of the total area under cultivation. The area of 32,216,000 acres sown during the year exceeded that of the previous year by 3 per cent., but as a result of the drop of 104 lb. in the yield per acre, the total outturn was only 7,736,000 tons—or 14 per cent. less than that of the previous year. The decrease in yield was due to cloudy weather when the crop was in ear, followed by hot winds just before it was harvested. The cloudy weather brought on a bad attack of rust in many parts of the wheat tract and the hot winds shrivelled up the grain before it had had time to mature properly. It is most gratifying to know that under these adverse conditions our Pusa wheats

gave much larger yields than the *desi* varieties and that the demand for Pusa wheat seed has increased very greatly in consequence.

Since the inception of the Imperial Agricultural Research Institute at PUSA, the production of high-yielding rust-resistant wheats of good quality and standing power has been kept in the forefront of its plant-breeding programme. Pusa 12, with its high yielding and tillering power, is one of the most popular wheats grown in the United Provinces. It is being grown, too, in the Simla Hills, the Eastern Punjab, Sind and some of the Rajputana States. Pusa 4, which is an early wheat of good standing power, with a strong straw and a large translucent grain of fine appearance, has proved particularly suitable for Bundelkhand and the North-West Frontier Province. Though these two varieties are both superior to the indigenous wheats in many respects, they suffer considerably from the depredations of birds and wild pigs, in parts of the country where awned wheats are normally grown, as a result of their being beardless. The demand from these localities for a bearded wheat of high yielding powers has been met by evolving Pusa 52—a bearded wheat obtained by crossing Pusa 6 with Punjab 9. This wheat has given high yields in Bihar where, in a year remarkable for the heavy incidence of rust as was that under review, it proved the most rust-resistant of all the Pusa wheats. Two new types of wheat (Pusa 111 and Pusa 114) were tested on a small scale during the past season. Pusa 111, fixed from a natural cross in Pusa 4, resembles the latter in all respects except that it has smooth glumes. It has proved even more rust-resistant than Pusa 4. Pusa 114 is a bearded variant of the famous Australian wheat Federation. Besides possessing these desirable characters, the new wheats promise to be superior to Pusa 4 in "hardness." Crosses between some of the improved Pusa wheats and Federation have reached the third hybrid generation. The severe attack of rust in the past season enabled selections to be made for rust-resistance.

The PUNJAB, which has over 34 per cent. of the total acreage under the crop in the whole of India, is the premier wheat-growing province. Of over nine million acres sown during the year in the

Punjab, 20 per cent. or 1,859,310 acres were sown with improved varieties. The variety the cultivation of which is encouraged by the department by organized seed distribution is one known as Punjab 8A; it is a better yielder and a producer of "stronger" flour than the older selection Punjab 11. First introduced in 1919, Punjab 8A has now spread over twelve lakhs of acres. Punjab 11 still occupies some five lakhs of acres. The other improved wheats under cultivation are Pusa 4, Pusa 12 and Punjab 17: their particular characteristics render them suitable for certain tracts.

Pusa 12 and Pusa 4 have received the widest recognition in the UNITED PROVINCES which is the second largest wheat-growing tract in India, carrying as it does over 23 per cent. (7½ million acres) of India's total wheat acreage. They occupied the bulk of the area of 1,115,000 acres under improved wheats during the year. In parts of the province where a bearded wheat is required, Pusa 52 and 54 are gradually replacing Muzaffarnagar which is prone to suffer from rust. In many villages in Bundelkhand and Oudh, the Pusa varieties were the only ones which gave an appreciable yield. In large scale demonstrations carried out by cultivators on their own fields they yielded twice as much grain as the *desi* wheats. To quote from the Report of the Provincial Director of Agriculture, "The *desi* wheat was lodged and frightfully damaged by rust. The Pusa wheat was standing well and very slightly attacked..... The net profit of those who grew Pusa wheat was double that of those who grew *desi* varieties." A cultivation experiment in progress at Cawnpore during the last six seasons has shown that the yields of wheat are materially increased by using a soil inverting plough instead of the country plough. The average gain works out at Rs. 39 and Rs. 28 per acre respectively, in the case of the Punjab plough working to a depth of 6-7 inches and the Meston plough working to a depth of 4-5 inches.

In the NORTH-WEST FRONTIER PROVINCE, where the wheat crop suffered from a combination of adverse climatic conditions rarely experienced before, the Agricultural Officer received reports

from all over the province to the effect that Pusa 4 had done much better than the local varieties. The area under Pusa 4 is already 330,000 acres or 33 per cent. of the total area under wheat in the province : as a result of its good performance last year, a great demand has arisen for seed.

The present indications are that Pusa 52 is suitable for cultivation in most of the wheat tracts of BIHAR AND ORISSA. Except at Sepaya where Pusa 80-5 gave the highest yield, Pusa 52 did better than any other variety with which it was compared. The department will continue to distribute Pusa 4, Pusa 52, and Pusa 80-5, until further experiments definitely determine whether it is really necessary to retain all the three varieties.

The calamity which overtook the wheat cultivators of the Northern Circle of the CENTRAL PROVINCES served to impress upon them the superiority of the departmental strains A. 115 and A. 113 in unmistakable terms. Even in areas where rust was most prevalent, these wheats produced a very fair crop, the average increased yield per acre over local rust-infected wheats amounting to 200-300 lb. It has been calculated that the money put into the pockets of the wheat cultivators by growing them during the year under review was in the neighbourhood of 13 lakhs of rupees. Their advantage over the *desi* wheats does not lie only in rust-resistance ; the high quality grain produced secures a premium over the best Pissi.

The superiority of Pusa 12 over *desi* wheats on the rain-fed areas of North SIND has been completely established, and the cultivators have adopted this variety as their standard wheat. The wheat-breeding work in progress at Sakrand promises to give a number of improved strains suitable for cultivation under irrigation. The comparative freedom of the Pusa varieties from rust was so marked wherever they were grown during the year in Gujarat and in the contiguous districts of the BARODA STATE, that a large demand has arisen for their seed.

In the Shan States, the cultivation of Federation and Pusa 4 continues to spread in the black and red soils respectively. Pusa 4, though less severely attacked by rust than any other variety

tried, has, however, proved unsuitable for the plains of BURMA, and a number of new foreign varieties has been imported for trial.

III. Cotton.

During the year under review, the area under cotton in India was 24,767,000 acres as compared with 24,822,000 acres in 1926-27. The yield per acre, expressed in terms of lint, rose from 81 to 95 lb., and the total estimated yield of cotton in 1927-28 was 5,896,000 bales of 400 lb., as against 5,024,000 bales during the previous season. The weekly cotton press returns from British India and Indian States showed that during the season 1927-28 the total number of bales of cotton pressed in India was 4,657,000 bales, as against 3,461,000 bales pressed during the previous season. The increase is due partly to a bigger crop, and partly to an increased number of Indian States, notably Hyderabad, having begun to compile press returns for the first time during 1927-28.

Though the season opened with the highest prices for Broach cotton in the Bombay market since March 1925, consequent on the rise in Americans on the publication of the September forecast, there was an immediate heavy fall in sympathy with the American market followed by a continued weakening till February. From then on there was a steady recovery until July, when with the publication of the American acreage figures the prices again declined. During the season the imports of American cotton fell to 67,000 bales from 325,000 bales during the previous season. The season, however, saw a slight improvement in the demand for Indian cotton from Europe and China, the total exports during the season having been 3,140,000 bales as compared with 2,830,000 bales in 1926-27. Indian cotton consumed in India in 1927-28 amounted to only 1,765,000 bales, as against 2,041,000 bales in 1926-27. The strike in the Bombay mills was responsible for the reduction in consumption of three lakhs of bales. The much larger Indian crop, and the substantial reduction in consumption, brought about a large accumulation of stocks of cotton in Bombay, *viz.*, 1,006,000 bales, which was the largest for many years, and more than double the stocks at the end of the previous season. The new season has therefore begun with a very large carry-over.

The Indian Central Cotton Committee has now completed its seventh year since its inception as an advisory body and its fifth year since its incorporation under the Indian Cotton Cess Act, 1923. The Committee's main work has been the improvement of cotton marketing, prevention of malpractices and the promotion of research for the improvement of cotton growing.

Cotton Transport Act. The working of the Act in those provinces and States which have introduced legislation, continued to receive the attention of the Committee during the year. Reference was made in last year's report to the removal of the restrictions on the transport of cotton *by road* between the three zones in the Surat District of Bombay, subject to the condition that no inferior cotton was grown in and around Sonsek. The Sonsek cotton-growers, however, persisted in abusing the concession, and the Committee had, therefore, to request the Government of Bombay to revoke the order removing the restrictions on the transport of cotton by road. It is expected that this matter will be placed before the Bombay Legislative Council at an early date. Through the absence of proper check on the transport of cotton by road in the three protected areas in the Southern Division, inferior cotton was being imported from outside into these areas. This has now been stopped by the establishment of sixteen road check stations on the boundaries of these areas. The recommendation of the Committee to constitute three more areas north of the Surat zones is now under the consideration of the Government of Bombay. During the year under review the Act continued in force in three areas in Madras, and though the trade was permitted to move *kapas* freely within the two southern areas, it was still possible to prevent the admixture of the valuable Northerns and Westerns, and Cambodia and Tinnevellys with Coconadas and the inferior cottons from outside the Presidency. Under the Act, no form of cotton is allowed to be imported into the areas except under a license granted by the licensing authority for specific purposes. This year, however, the Director of Agriculture tried the system of granting licenses freely for the import of cotton seed for feeding cattle, and this concession was in some instances abused and the seed used for sowing purposes. Licenses to the number of 3,220 were issued

during the year as against 1,811 in the previous year. Of these only 870 licenses were actually used, and no less than 825 of them related to cotton seed imported for cattle food. The total quantity of seed accounted for in these licenses was 13,414 tons, of which 10,868 tons were imported from outside the Presidency. From the beginning of the operation of the Act the trade was opposed to the two notified areas in the south of the Presidency, as they constituted a check to the free movement of seed and *kapas* from some of the distant fields to established ginning factories. The opposition grew stronger, and the Government of Madras eventually decided to constitute a single protected area consisting of the North Arcot and Chingleput Districts and all the cotton-growing districts lying to the south of them. A notification has recently been issued to this effect with the approval of the Legislative Council. The important feature of the new notification is that no restriction whatsoever is placed on the movement of cotton seed from and into the protected areas. It is yet to be seen how far this policy will hinder the Agricultural Department in their attempt to establish improved strains of cotton on soils suitable for them.

The improvement already found in the quality and reputation of the cottons of the Baroda, Rajpipla and Chhota Udepur States justifies the legislation introduced. The Hyderabad State has also followed suit and has protected the area growing the valuable Bani or Hyderabad Gaorani cotton. In Indore a Cotton Transport Bill is now before their Legislative Committee. This step should go a long way to rehabilitate the reputation of the Malwa cottons, and with the Institute of Plant Industry working on an improved type for the tract, the prospects for the growers in this area are very bright.

Cotton Ginning and Pressing Factories Act. The Committee continued to give considerable attention to the operation of the Act. The Indian States are equally alive to the usefulness of the Act, and more than forty have already introduced or agreed to introduce similar legislation. From thirty of these, press lists have been obtained and published. The press returns from these States should add greatly to the usefulness and completeness of the all

India Weekly Cotton Press Returns published by the Director-General of Commercial Intelligence and Statistics. Considerable anxiety was caused in the early parts of the season in Bombay trade circles by a large number of consignments being declared "not a fair tender" in the East India Cotton Association arbitrations owing to bales being faultily marked. Immediate relief was, however, given to the trade by the Government of India who notified a proviso to Rule 7 of the Indian Cotton Ginning and Pressing Factories Rules, by which it was only necessary that the marks on the bales should be decipherable to fulfil the conditions of the Act. The Committee also brought to the notice of the Local Governments and Indian States concerned the haphazard way in which marking was carried out in certain presses. Certified copies of the press registers pertaining to bales rejected for malpractices in the East India Cotton Association arbitrations were obtained and posted on the notice board of the Association. During the year under review the Madras and Bombay Governments issued rules regarding the weights and scales to be used in the factories, and defined the standards of tolerance and sensibility.

Cotton finance and marketing inquiries. The five investigations mentioned in last year's report were completed, and the statistics collected have now been written up and summarized. It appears that, in general, the cotton-grower has adequate facilities for obtaining loans, both for cultivation and non-cultivation purposes, without any security and without any obligation regarding the subsequent disposal of the crop. On an average about 70 per cent. of cultivators take loans. The *sowcar* is the most important lender, and 55 per cent. of the total loans recorded was borrowed at 12 per cent. or less. In Sind, however, the cultivator is not so well off in these respects. As to marketing facilities it may be stated that, on the whole, the organization and rates in villages are generally satisfactory, and the cultivators prefer to sell their produce, chiefly in the form of *kapas*, to the petty buyers in the village itself. Barring Sind and middle Gujarat, the cultivators appear to be able to hold, and do hold their produce to a certain extent till the market is favourable.

Advance sales to cover debts are rare, but speculative advance sales do occur.

Primary cotton markets. Reference was made in last year's report to the recent Bombay Cotton Markets Act. The Rules under this Act are now being considered by the Government of Bombay. The success of the system under which the control of the Sanawad market in the Holkar State was vested in a Market Committee with representatives of cotton-growers on it, led to the formation of a similar one at Barwaha. It is expected that two more markets will be started in the near future. H. E. H. the Nizam's Government also proposes to set up as an experimental measure a regulated market on similar lines at Parbhani. The Central Provinces Government has also published revised market rules which allow for the representation of growers on the Market Committees.

Marketing of improved cottons. The basis, *viz.*, " Strict Low Middling ", of the Empire and Miscellaneous Growths Futures Contract started by the Liverpool Cotton Association from September 1st, 1925, was, in the opinion of the Indian Central Cotton Committee, too high to allow many Indian cottons to be tendered against this contract. The Liverpool Cotton Association has now agreed, at the request of the Committee, to lower the basis to " Low Middling " from 1st July, 1929. This is a definite advance and should foster trade in the stapled Indian cottons in the Liverpool Futures market. Type bales of the improved varieties of Indian cottons were supplied to the Liverpool, Manchester, and Bombay Cotton Exchanges. The technological reports on standard Indian cottons were made available sufficiently early to enable the trade to judge of the merits of the cottons almost as soon as they came into the market.

Measures to prevent the introduction of the Mexican boll-weevil. As already stated, imports of American cotton were considerably less than last year, and the Bombay Port Trust was able to arrange for fumigation within the docks, thus affording importers much greater convenience in handling cotton after delivery.

Cotton statistics. The Committee continued the publication of the weekly statistics relating to the purchases, actual imports and

shipments of American cotton. The monthly statements of Indian raw cotton consumed in British India and in the Indian States, and of loose cotton received in mills in the major cotton-growing provinces were also issued regularly. At the instance of the Committee the Government of India also agreed to re-introduce the monthly statement showing both the exports of raw cotton by rail and river and the destination of exports. Improvement in the Fifth (Supplementary) Cotton Memorandum issued in April has been effected by the introduction of a fifth forecast in Bombay and Baroda. The Durbars of Hyderabad and Mysore have also agreed to do likewise. Other provinces and States have promised to inform the Director General of Commercial Intelligence and Statistics of any substantial change in the character of the crop which may take place after the issue of the Fourth Memorandum.

Cotton research. The Committee's Technological Laboratory, which provides the cotton-breeder with a clear idea of the fibre properties and the spinning value of his selections at an early stage in his work, tested during the year 59 samples of cotton for various agricultural officers. A distinct forward step, much appreciated by the trade, was made by publishing separately in leaflet form the reports on the more important standard Indian cottons as soon as the tests on each sample were finished. Complete bulletins containing the reports on all the standard Indian cottons of 1926-27 and 1927-28 were also issued. Incidentally these tests on the same cottons from year to year will prove of great value for the study of seasonal variation. The most arduous part of the work in the laboratory is done in the fibre-testing section where every sample received is tested to determine its physical properties such as length, length distribution, weight, strength, rigidity, ribbon width, number of convolutions and the clinging power of the fibres. It is also of interest to note that during the year small pieces of textiles obtained from the archæological excavations at Mohenjodaro in Sind were examined at the laboratory and identified as cotton.

The work at the Institute of Plant Industry, Indore, the major portion of the finances of which is met by the Committee, is steadily being pushed forward, and already many useful results have been obtained. That the number of the contributing States has

increased from eight to thirteen during the last four years is convincing proof that the scope and usefulness of the Institute are being increasingly recognized by the Central India and Rajputana States. The Institute and the farm cover an area of 300 acres, and of this about 60 acres were devoted to cotton and cotton experiments during 1927-28. The Institute first tackled the problem of an early maturing cotton suitable for the Malwa plateau, and set itself to discover the factors which limit the growth of cotton in this tract. Considerable progress has already been made in the work of isolating a superior strain of Malwa cotton, and the problem of supplying the soil with combined nitrogen in a suitable form has to some extent been solved by working out a method for the preparation of Chinese compost from crop and farm refuse. A preliminary survey of the root-development of certain types of cotton was also done during the year. The year's work in cytology consisted of the determination of the number of chromosomes in 32 types of cotton, and the results confirmed Denham's observation that the Indian cottons possess double the number of chromosomes of American cotton.

The Committee is also financing thirteen distinct research schemes on problems relating to cotton in the major cotton-growing provinces. Five of these are in cotton breeding, two in cotton mycology, and three deal with entomological and physiological problems.

The Madras *herbaceum* scheme at Coimbatore under the direction of the Cotton Specialist has just finished its fifth year of work. It was started in order to obtain pure line selections of the Uppam (*herbaceum*) type of cotton suitable for a tract of light rainfall. Four strains, selected for better yield and ginning outturn, have been found to be equally good, if not superior, in spinning qualities, to ordinary Uppam. They have now to be tested on a field scale so that the most profitable of them may be finally selected for distribution.

The Economic Botanist to Government under the Central Provinces and Berar Botanical Scheme at Nagpur has succeeded in isolating a type of cotton known as *G. neglectu n Verum* No. 262,

which has a higher yield, a ginning outturn of 35, is wilt resistant and spins up to 24s warp. The local mills have shown great interest in this cotton which fetched a premium up to Rs. 100 on Broach last year. The elimination of the khaki lint in the Chanda " Jari " crop has also been successful and seed of a pure white strain has been distributed. The programme of work under this scheme included also an investigation into the causes of the low yield of cotton in Berar, and certain aspects of this problem have now been successfully investigated on the Akola farm. The soil of Berar has been exhausted by successive cropping with very little replenishment and the problem resolved itself into discovering a cheap but effective manure. The efforts have been fruitful and a method of preparing an organic manure comparatively rich in nitrogen from cotton stalks and other farm refuse has been worked out. The effect of phosphatic fertilizers on the yield of cotton is also being investigated. Under the conditions obtaining in Berar a system of rotation with a leguminous crop is imperative for increasing the nitrogen supply. In the rain-fed tracts of Berar the cultivator does not sow his seed until he is sure of his sowing rains, with the result that in a year of short rainfall the plant has often to grow and develop in a soil the moisture content of which is gradually diminishing. The problem, therefore, to be solved in these tracts is that of finding a type of plant the water requirements of which fit in with the water conditions of its environment. Further research in this direction is now being done.

The Punjab Botanical Scheme has just completed its third year and considerable progress has already been made with the work in hand. Some promising families are under observation among the 176 pure lines of both American and *desi* cottons maintained. One of the new *desi* types, a *Gossypium sanguineum* variety, has attracted much attention; it has been handed over in bulk to the British Cotton Growing Association at Khanewal for propagation. Experiments designed to find out the most suitable time for sowing, the optimum number of waterings and the interval between waterings, are also being carried out. The daily growth records, the flowering and the bolling records of several plants

of the three American types, 4F., 285F. and 289F., along with the records of the atmospheric and soil conditions, should in due course furnish a mass of material of great value. The work of maintaining the purity of the seed supply of 4F., 285F., 289F. and Mollisoni by large scale roguing of the fields continued as usual. The total area thus rogued comprised 90 acres.

The plant-breeding scheme at Dharwar aims at improving the staple length of Dharwar-American cotton. It has now completed its fifth year, and the results achieved fully justified its extension for another term of five years. Dharwar-American is the only American cotton which is now being grown in India on unirrigated soil and any improvement in its staple length will be very welcome. Gadag No. 1, a selection made by the Bombay Agricultural Department from Dharwar-American, has already established a reputation, and as a result of the present research work a cross between Gadag No. 1 and Sea Island made in 1920, which is superior to Gadag No. 1 in staple length and ginning percentage, has been evolved. At Dhulia in Khandesh, the Committee supplemented the plant-breeding work of the Department of Agriculture by providing funds to enable the employment of additional staff for the purification and testing of several improved cottons which have been isolated from a Bani-Comilla cross made several years ago. Two of the most promising of these, *viz.*, Dhulia I and Dhulia II, were tested on a large scale, but Dhulia II was susceptible to wilt and has been rejected. About 150 bales of Dhulia I, which spins up to 20s warp counts compared with 8s to 10s of the ordinary N. R., have been placed on the market this year. Another selection with a ginning percentage of 35, and spinning up to 30s, awaits a thorough test for yield and wilt resistance.

The Committee financed two investigations, one at Dharwar and the other at Nagpur, into the causes of the wilt disease of cotton and methods of checking it. At Dharwar the conclusion arrived at was that the wilting was not caused by the clogging of the vascular ducts by the mycelium of the *Fusarium*, but by a chemical substance or toxin emitted by the fungus. The most promising method of combating this disease appears to be in the

production of wilt-resistant varieties. The scheme has, therefore, been extended for another term of five years for the production, purification and testing of wilt-resistant varieties. At Nagpur the work was chiefly confined to the study of the physiological aspect of the problem, and the conclusion was arrived at that the wilted condition of cotton plants was not pathogenic, but physiological.

Under Entomology the Committee directed its attention to the pink boll-worm pest so prevalent in the United Provinces and the South-East Punjab. The work in the United Provinces has now conclusively proved that a heavy loss is sustained by the grower from this cause, and that the sowing of heat treated seed at an expenditure of six annas per acre yields a profit of Rs. 30. It has been proved, however, that no half-hearted methods will be successful, as all the seed used for sowing and feeding must be subjected to the heat treatment. In the Punjab, the investigations seem to show that the factor which limits this pest in the Canal Colonies is the temperature. The results now obtained have however to be confirmed by further investigations. At Surat the study of the life-history and possible methods of controlling the *Earias* boll-worm pest have led to the discovery that the moth lays its eggs during the night, that the larvæ invariably pupate in the soil, and that the cotton stalks left in the field afford a suitable resting ground for the carry-over from season to season. Remedial measures based on these facts have been devised and found successful.

Three investigations are being financed by the Committee for the purpose of studying the physiological conditions which cause the loss of buds and bolls by shedding in Surat and in Madras, and the water conditions under which the best cotton can be grown in Sind. At Surat it has been ascertained that the principal cause of shedding is the lack of elaborated plant food due to interaction of the growth processes of the plant. Four different remedial measures have been suggested, the cumulative effect of which is expected to give a 100 per cent. increase in the crop. Further experiments will be conducted in the next few years to test the accuracy of these conclusions. No work has been done under the Madras

scheme because of the difficulty of obtaining a qualified Physiological Botanist. In Sind the work has recently commenced.

Work in the Provinces. Detailed reference has already been made to the research being carried out in the BOMBAY PRESIDENCY on cotton with the help of funds provided by the Indian Central Cotton Committee. Bombay is the largest cotton producing province in India: it has in a good year an area of over 8 million acres under cotton and possesses four distinct trade varieties. The Department of Agriculture has always been alive to the importance of this crop. In addition to the comprehensive research programme that is being carried out in Sind, there are no less than seven distinct problems under investigation in the four tracts mentioned above. Each of these tracts has its own plant-breeding scheme, while cotton wilt at Dharwar, bud and boll shedding in Gujarat, and the boll-worm pest in Surat are also being investigated separately. Special attention is being paid by the department to the organizations for the distribution of seeds of improved types of cotton. The departmental staff is able to develop under direct control the spread of a new variety up to 10,000 acres, but to go beyond that some other organization is required which has sufficient resources at its back to assist the cultivators financially. The co-operative agencies and the Taluq Development Associations are of great assistance in this connection, but occasionally these break down on account of their limited resources.

The work on *herbaceum* cotton carried out in MADRAS during the year under review has already been referred to. The strain Co. 440 has maintained its superiority over the other Cambodia strains. It is a better yielder, more vigorous in growth and less susceptible to the attacks of insect pests. Further spinning tests have now confirmed the view that this cotton is capable of spinning 36-38s warp, while the best known Cambodias, Co. 1 and Co. 664, spin up to 40s warp. Having thus succeeded in evolving a strain desirable in every respect for the Cambodia tract, the department has now turned its attention to the cultural and manurial aspects of the problem. A preliminary experiment conducted during the season under review made

the startling disclosure that the sowing time, if delayed for a month, reduced the yield by more than 75 per cent. If the results of future experiments confirm this finding it should be possible to devise safeguards of great economic importance to the tract, by which the cultivator will be fully protected from the vagaries of the season, *viz.*, the sowing rains, at the mercy of which he now is. It is yet too early to draw any conclusions from the results so far obtained on the new cotton sub-station at Koilpatti, and from the hybridization work carried out at Coimbatore. At Hagari, however, H. 62 has for the fourth year in succession proved itself superior to H. 25 both in yield and ginning outturn. The department has, therefore, decided to replace H. 25 with H. 62, which will hereafter go under the designation H. 1. With a view to devising possible methods of control, the boll rot and seedling blight of cotton caused by a fungus called *Vermicularia* was also studied in detail and its physiology worked out. It is interesting to note that the seed farm area is steadily increasing; from about 3,500 acres in 1926-27 it has gone up to about 7,000 acres in 1927-28.

The progress made in the PUNJAB with the schemes financed by the Indian Central Cotton Committee has already been referred to. For the fourth time during the last nine years the crop of Punjab-American cotton was a failure during the year under review. After comparing the character of the last two seasons with those of the previous two years of failure, *viz.*, in 1919 and 1921, the Director of Agriculture has come to the conclusion that the failure of the crop in the hottest and driest part of the country is due to a kind of "heat stroke" produced by a rise in the temperature of the protoplasm consequent on the abnormally high temperature and low humidity during the months of September-October, when the cotton plant is in full leaf, and is under the maximum strain of flower and boll production. An adequate supply of water during these months, and interculture to conserve soil moisture should, in his opinion, greatly reduce the risk. The matter, however, has been referred to an expert Committee to prove or disprove definitely the above tentative conclusions. The seriousness of the situation can be gauged from the heavy reduction caused in

the area under cotton by the 1926 failure. From an area of 2,500,000 acres in 1926 it fell to 1,800,000 acres in 1927.

The major cotton research work in the UNITED PROVINCES, *viz.*, the inquiry into the possibilities of controlling the pink bollworm (*Platyedra gossypiella*), has already been referred to. Considerable progress has also been made in the introduction of improved varieties. The selected short staple cotton A. 19 of the Western Circle has become very popular, the area under it during 1928 having risen to 60,000 acres. Though this variety is not superior in staple to the local cotton, it is profitable to the ryot as it is a good cotton of its class and a very heavy yielder with a high ginning outturn. The Agricultural Department, therefore, proposes to introduce this variety in other parts of the province also. For another year the department's selection Cawnpore 402 has maintained its superiority. Some 25 bales of this variety sent to two Bombay mills have been favourably reported upon, and a premium up to Rs. 50 per candy over Bengals offered for it.

Selection No. 1·35, an early maturing American cotton of medium staple, has been found suitable for the districts of West BENGAL. Work on Comilla cotton continued on the Rangamati farm in the Chittagong Hill Tracts.

In BURMA, the experiments with the department's Pwinbyu Wagale on the Allanmyo farm confirmed the results obtained in previous years. Wagale, on account of its shorter growing period, fares well in this tract. Trials with Coimbatore 1 have proved that it is the best yielder of all the cottons tried on the farm. It is also superior in staple both to Wagale and Wagyi. Several pure line selections from Wagale and Wagyi were kept under observation and selections from Wagale, and Wagyi × Wagale hybrids were also made during the year. From the 45 demonstration plots in the district, 72,000 lb. of selected seed, mainly of Wagyi, were distributed. Further tests carried out on different types of soils have now definitely established the superiority of the selection C. 19 both in ginning outturn and yield. This strain is now being multiplied for distribution.

In their effort to rehabilitate the reputation of the Bani (HYDERABAD Gaorani) cotton, the most important step, *viz.*, the protection of the area from the encroachment of inferior types by legislation on the lines of the Indian Cotton Transport Act, has already been taken by H. E. H. the Nizam's Government. The Department of Agriculture is now steadily working to eradicate the existing deteriorated types from the protected area by distributing seed of pure Bani. Organized sales of cotton by auction under departmental supervision have also been introduced at Parbhani to ensure that the growers obtain a legitimate price for the produce. In the Raichur District, the department distributed pure seeds of Gadag 1 and Dharwar 1.

In the MYSORE STATE, Sanahatti No. 69, a selection from the indigenous type of *G. herbaceum*, now occupies an area of 25,000 acres. Absence of proper control over the seed supply in the early stages of its distribution has resulted in the crop becoming mixed, and steps are now being taken to remedy this. Experiments are being carried out to obtain a suitable wilt-resistant type of cotton for the wilt affected tract. A cross between *G. arboreum* and Sanahatti No. 69, which possesses all the agricultural characters of Sanahatti No. 69 and certain easily distinguishable morphological characters of *G. arboreum*, reached its sixth generation during the last season.

The Agricultural Department of the BARODA STATE continued its policy of distributing pure seed of the 1027 variety in the Navasari District, a matter which is of great importance to the adjoining British territory. In parts of the Baroda District where heavy rains did not damage the crop, the Broach Selection 9¼ did well. There are now nine co-operative societies in the State organized for the sale of cotton on a co-operative basis. These societies, five of which functioned during the year, were of great help to the department in the distribution of pure seed, and did considerable business in the crop produced therefrom.

At the Central Experimental Farm, Ujjain, GWALIOR STATE, experiments were carried out with Cambodia, and with Malwa

and other unirrigated cottons. Owing to various limiting factors the successful introduction of Cambodia in the State is problematic. A type of Malwa with a higher ginning percentage should do well in this tract.

IV. Sugarcane.

During the year under review, weather conditions were reported to be generally favourable and the condition of the cane crop to be fairly good. According to the Final General Memorandum issued by the Department of Commercial Intelligence and Statistics, Calcutta, the area under sugarcane was estimated to be 2,954,000 acres, as against 2,924,000 acres last year, or an increase of 1 per cent. in area. The estimated production of raw sugar (*gur*) was 3,221,000 tons as compared with 3,255,000 tons last year, a decrease of 1 per cent. in production. This estimate does not include the sugar produced in tracts where cane is grown only on a small scale. The average sugarcane area in these tracts for the last five years has been estimated at 151,000 acres and the yield of raw sugar (*gur*) to be about 166,000 tons.

The manufacture of refined sugar in India during the year 1926-27 by factories working direct with cane amounted to 62,941 tons as against 52,990 tons in 1925-26, and the output of modern refineries working with raw sugar (*gur*) was 58,086 tons in the same year as against 38,409 tons in 1925-26. The total production of refined sugar in India during the year 1926-27 was thus 121,027 tons as against 91,399 tons in the previous year. This is exclusive of the sugar made by small establishments working on the indigenous manufacturing processes.

During the official year 1927-28, the imports of sugar into India amounted to 725,791 tons. After deducting exports of home-made sugar, re-exports of foreign sugars and stocks on 1st April, 1928, at the principal ports in India, it is estimated that about 886,334 tons of imported and locally manufactured white sugar was consumed in India during the official year 1927-28, as against 853,173 tons in the preceding year. This is exclusive of the

raw sugar (*gur*) manufactured locally, the whole of which, with the exception of 112,464 tons melted by the refineries and about 6,335 tons exported from India, was consumed in the country.

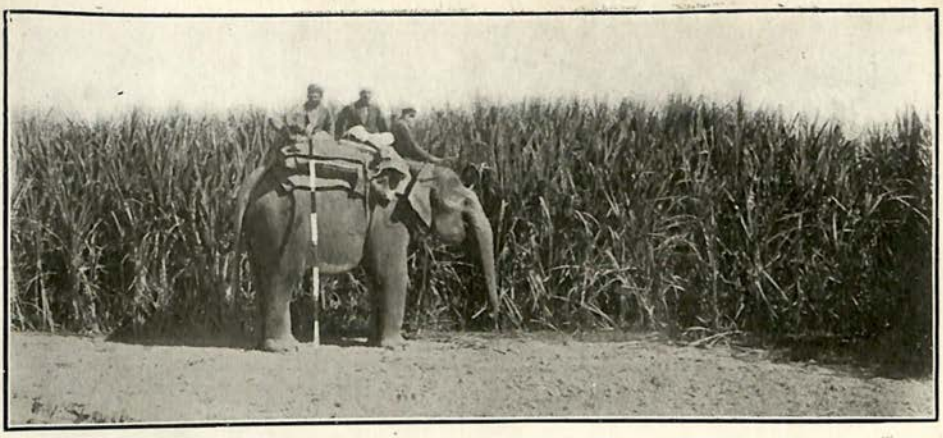
The IMPERIAL SUGARCANE BREEDING STATION AT COIMBATORE continued the breeding work on the lines mentioned in the previous review. The change of parents referred to therein has been fully justified by the results. Attempts were made to effect a further improvement in breeding technique. In spite of recent improvements in this direction, it has not yet been possible to cross varieties which flower at different periods. To overcome this obstacle experiments were in progress (1) to store the pollen in viable condition, and (2) to hasten or retard the flowering by manipulating the crop. Considerable progress was made in the breeding of thick types of canes; a large number of crosses was made during the year. Two new lines of work undertaken during the year were (1) the study of the relative rind hardness of sugarcanes and (2) the study of possible leaf adaptations conducive to mosaic resistance. There has been a phenomenal spread of the Coimbatore canes in the United Provinces. Co. 213 is the variety most widely grown; but Co. 290 introduced more recently promises to be a better cane. It is highly resistant to mosaic and ripens earlier. Co. 281 has given a good account of itself in Cuba and Florida.

A separate area of about 143 acres on the PUSA estate known as the "New Area" is being devoted mainly to sugarcane experiments in which many varieties of cane, varying seed-rates, manures, and spacing distances in planting are being tested. Among the new Coimbatore canes tested on a field-scale, Co. 270 gave the largest yield of stripped cane in the year under review. Some of the more recent arrivals which are still in the nursery are very promising. Analyses carried out in December 1927 showed that four of them contained over 19 per cent. sucrose. A *gur*-making experiment carried out during the year showed that in a season like 1928, when *gur* was selling at an abnormally low price, it was more profitable to sell whole canes to the nearest sugar mill than

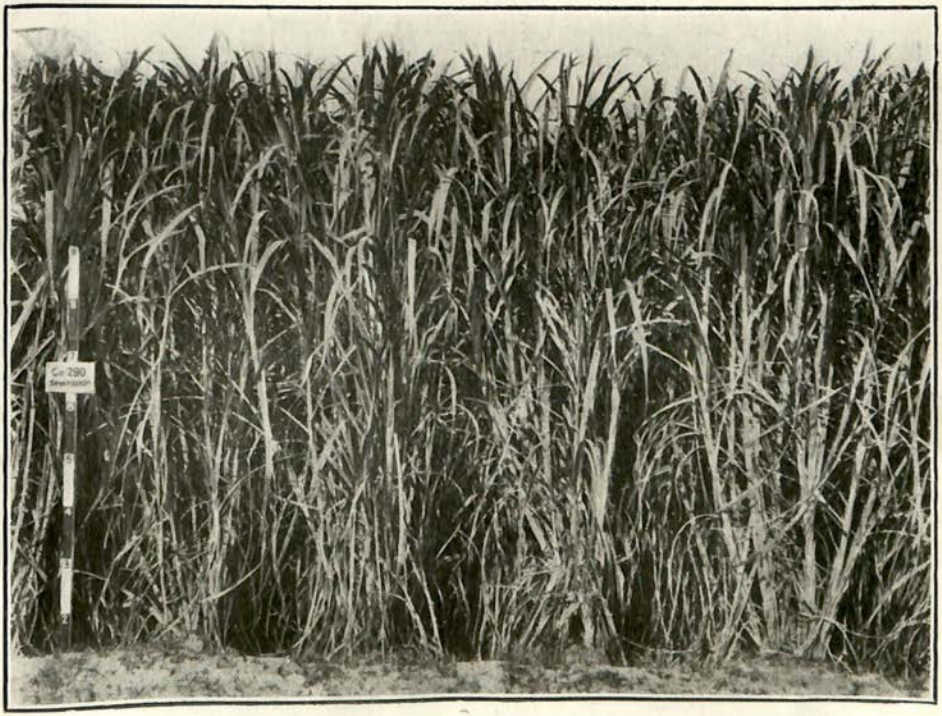
to use them for *gur*-making. As the Secretary of the Sugar Bureau has been relieved of the agricultural work on cane at Pusa, he is now able to devote more time to the extension of the area under selected Co. canes. With a view to obtaining further data regarding the varieties which have proved suitable at Pusa, he carried out field tests at three centres in Bihar, the results of which indicate that Co. 287 and Co. 290 are heavy yielders. Co. 205 has been well established both on low-lying and high lands; this hardy cane does well on both. During the year under report, the services of the Secretary were lent to the Governments of Bombay and the Punjab and to Messrs. Finlay, Fleming & Co., Burma, for short periods.

Co. 290 has given excellent results in the three main sugarcane tracts of the UNITED PROVINCES, namely, Gorakhpur, Rohilkhand and Meerut Divisions. Under the Java system of cultivation and with a rainfall of 42 inches, supplemented by 25 inches of irrigation water, this cane gave on an average 45 tons of cane and 4·4 tons of commercial sugar per acre. Considerable attention has been paid in this province to the question of mosaic and arrangements have been made to supply disease-free seed. Co. 213 and Co. 205 are gaining popularity in the province.

The highest yield of *gur* at the Lyallpur farm in the PUNJAB was again given by Co. 205 which yielded on an average 55 cwt. per acre; Co. 210 gave 54 cwt. and Co. 223 gave 47 cwt. At Hansi Co. 285 gave the best results for the second year in succession; it yielded 66 cwt. of *gur* per acre. In Karnal District, Co. 213 is finding favour with growers. A sub-committee has been formed to deal with the question of mosaic and assistants are being trained to recognize the disease and to rogue out affected plants. Co. 205 continued to gain favour on *barani* (rain-fed) lands, while Co. 223 has given a good account of itself in irrigated areas. Rains at the end of December and beginning of January were beneficial to the crop, but the season on the whole was not very favourable, yields being normal on irrigated and below normal on unirrigated areas.



Co 213 in the ryots' fields at Nawabganj (United Provinces).



Crop of Co 290—a 1924 seedling—at the Shahjahanpur Farm. (The measure rod in both figures is marked in feet.)

In the NORTH-WEST FRONTIER PROVINCE, the chief line of work on cane is the testing of Assami Red against the local Peshawar Pounda or Otaheite. Assami Red is superior to the local Pounda in so far as it is less liable to damage from borer, jackals and red rot. What is really required is a thick soft variety which is suitable for chewing, immune to disease and produces a high class *gur*. Tests with Co. canes have been undertaken at Tarnab but no better cane than Assami Red, which is now being distributed in the Peshawar Valley, has yet been found. A future for Co. canes appears to lie in Hazara which requires a hardy medium cane which will give a good yield and also ratoon well. Co. 213 is coming into favour in this district; Co. 281 and Co. 290 are under trial.

In North BIHAR, the most impotrant sugarcane area in the province, the Co. canes are estimated to cover an area of over 15,000 acres. The bulk of the cane crushed in some of the sugar factories now consists of Co. varieties. Cane setts to the amount of 200 tons were supplied from the Sepaya and Darbhanga farms. There is no doubt that a valuable series of canes for the North Bihar Range is now available. Co. 205 has proved of great value for water-logged areas: about 62 tons of this variety were sold for planting. Over the rest of the province, Co. 213 is rapidly extending. It is in steady demand in Chota Nagpur and has brought about a remarkable increase in cane cultivation in Sambalpur. In Orissa Co. 213 is very popular; the area under it increased from 338 in 1926-27 to 1,183 in 1927-28, while the yield of *gur* per acre is reported to have frequently reached 66 cwt. In South Bihar, where the crop is irrigated, Co. 213 is rapidly replacing the local canes, and in South-East Bihar it is common throughout the sugarcane tract.

J. 247 is rapidly becoming popular in MADRAS on account of its resistance to disease and drought; in some localities 85 per cent. of the cane grown is of this variety. At the Anakapalli Experiment Station the system of short planting for seed has now been thoroughly tested and is being recommended to the ryots for adoption. The economics of the system have been carefully worked

out, and it shows an increased profit over the local methods of over Rs. 118 per acre. Considerable attention has been paid to improved cultural methods, proper manuring, propping and wrapping, and to the use of improved mills and furnaces. The Sindewahi furnace has now become universally popular. In the Chingleput and South Arcot Districts 100 more furnaces were built for ryots in the year under review.

The main work on cane in ASSAM is concentrated at the Jorhat farm where a prolonged drought severely affected the outturn of the experimental plots. P. O. J. 2714, Co. 210 and Co. 213 have given the highest yields, both as plant and ratoon crops. The outturn of J. 247 on the manured area was nearly double that on the unmanured plot, while H. 109 was very poor on unmanured land though up to average on manured. The McGlashan furnace was tried and proved to be very economical.

In BOMBAY, the chief and most important investigation on cane is directed towards the cheapening of the cost of growing cane in the Deccan. The cultivation of cane has become unprofitable in many places as a result of the big drop in the price of *gur*. The Agricultural Department has, in collaboration with the Irrigation Department, been paying special attention to the diversification of crops in the canal area. Whether this will solve the problem or merely increase the debit against the canal is to be seen. Power crushing plants on the Deccan canals now number 52 : during the year under report the Agricultural Department gave cane-growers valuable assistance in installing new mills. The need for introducing labour-saving devices is becoming more and more evident on the canals.

Co. 213 has established its reputation in BENGAL, and is likely to replace both the local canes and Tanna. During the season the department issued to cultivators $7\frac{1}{2}$ lakhs cuttings, of which $6\frac{1}{2}$ lakhs were of Co. 213. Five new varieties tried at Dacca were P. O. J. 2499, 2696, 2714, 2725 and 2727.

At the Pyinmana farm in BURMA the highest yields were obtained from the sugarcane varieties Tungoo-yellow (Otaheite) and B. 376.

J. 247 and Ashy Mauritius were discarded owing to their low juice content. Mosaic and streak disease were under investigation at Tatkon. Artificial inoculation experiments with leaf sap were unsuccessful. The beetle pest (*Alissonotum impressicole*) of cane, which had in former years done great damage at the sugarcane estate at Sahmaw, was brought under control by collecting and destroying the grubs at ploughing time. Ten improved *jaggery* furnaces were constructed by the department for private owners. At the Sahmaw estate of Messrs. Finlay, Fleming & Co., about 1,400 acres were under cane and the manufacturing of white sugar was commenced.

The breeding work in MYSORE has provided one variety called H. M. 544 which is now being grown quite extensively in the State. A promising sport from H. M. 544 has appeared on the Babbur farm.

V. Jute.

Although jute occupies only 1·3 per cent. of the total area under cultivation in British India, it contributes 26 per cent. of the export trade of the country. In the supply of jute fibre, India enjoys a worldwide monopoly. The record crop of the previous year having resulted in a drop in the price of the raw product, the area shrank in 1927 to 3,374,000 acres, which was less than that of the 1926 season by 12 per cent. There was a decrease in the yield, too, with the result that the total outturn was 16 per cent. less than that of last year. Owing to a brisk demand by spinners both in India and abroad, prices were well maintained in the year under review. The total weight of raw and manufactured jute exported increased from 15·7 to 17·8 lakhs tons and the value from Rs. 80 to 84·2 crores.

Nearly 85 per cent. of the area under jute is in BENGAL, and it is to the credit of the local Agricultural Department that it has isolated and brought into general cultivation high-yielding, disease-resistant strains of the two main species cultivated, *viz.*, *Corchorus capsularis* and *C. olitorius*. On an average these departmen-

tal selections yield 25 per cent. more fibre than the local varieties; during the year under report they occupied 984,215 acres or over 33 per cent. of the total area under the crop. The rapidity with which they are spreading will be evident from the fact that the area under these improved varieties has increased by over 200 per cent. in four years and by almost 100 per cent. in one year. Manurial trials extending over a long period have given definite evidence that, on the red soils of Bengal, lime and potash, when applied along with a general manure, considerably increase the yield of jute.

On the Purnea farm in BIHAR, Green Chinsura has given high yields for three years in varietal tests which included not only the local varieties but also D. 154 and Kakya Bombai. The varieties under distribution in ASSAM are the Dacca selections Kakya Bombai, R. 85 and Chinsura Green: they have proved the most productive of the varieties tried in the villages. The cultivation of jute is making progress in the Ganjar tract (Kheri and Sitapur Districts) of the UNITED PROVINCES where conditions are similar to those obtained over large areas in Bengal.

VI. Other Fibres.

Sann-hemp. Cannabis sativa, Agave sisalana, Hibiscus cannabinus and *Crotalaria juncea* are the four principal fibre crops, the produce of which is known as hemp. It is, however, the last named, known generally as sann-hemp, which is of most importance. It produces fibre which, for its natural strength, colour and other inherent qualities, is much appreciated in foreign markets; it supplies, too, a cheap but valuable organic manure. At present sann-hemp is grown either for fibre or for use as a green manure: experiments at Pusa have, however, shown that the same crop can be used economically for both—the tops for manure and the stems for fibre. In the United Provinces, an improved variety of sann-hemp has been isolated, and its seed is being multiplied for distribution. At Pusa an enquiry is in progress into the factors which influence the sex ratio in the true hemp *Cannabis sativa.*

Agave. The possibility of utilizing a power sugarcane crushing mill for extracting fibre from the leaves of sisal-hemp is being investigated at Dacca in Bengal. The commercial value of the exuded juice is also being tested.

VII. Tobacco.

From over a million acres cropped with tobacco in India, nearly 1,000 million lb. of dry leaf is harvested. The latter figure represents about 20 per cent. of the world's total production and about 90 per cent. of the total production of the British Empire. In spite of her pre-eminent position among tobacco-growing countries, India does not enjoy a proportionate share of the international export trade in this commodity. The reason is that practically all the indigenous tobaccos of India yield a dark coarse leaf giving a strong and pungent smoke: none of them possesses the properties of a good cigarette tobacco which is most in demand in the world's markets. India herself had to import last year 4 million lb. of Virginian tobacco valued at Rs. 32 lakhs and 5·6 million lb. of cigarettes of the value of Rs. 240 lakhs. It is obvious that if these imports could be replaced wholly or even in part by the home grown leaf, a considerable saving would be effected. There is also the export trade to be taken into account. It consists mainly of unmanufactured tobacco which is used principally for mixing with other leaf in the preparation of pipe tobacco. Owing to the increasing consumption of cigarettes, at the expense of pipe tobaccos and cigars, the world's demand of Indian coarse leaf is steadily on the decline: only 28 million lb. of unmanufactured tobacco were exported in 1927-28, as against 29 in 1926-27, 37 in 1925-26 and 43 in 1924-25. India could increase her exports and profit by the preference given to Empire-grown leaf in Great Britain which is our best customer and the world's principal manufacturing centre, by producing a high grade cigarette tobacco. The aim of the Imperial Agricultural Department therefore is to produce a tobacco of the colour, flavour and texture of that which is commonly called Virginian.

At PUSA, the production of a high grade cigarette tobacco is being attempted. The well-known American variety Adcock is being acclimatized : the conditions of cultivation suited to its successful culture are being studied, and improved methods of curing and maturing the leaf are being tried. A considerable measure of success has been achieved in all these three directions. It has been ascertained that a good outturn of leaf can be assured in Bihar by sowing and transplanting Adcock earlier than the indigenous varieties ; that a light sandy soil with little or no nitrogenous manure is required for the production of leaf of good quality; that cigarette tobacco of a quality superior to any produced in India heretofore can be obtained by flue-curing in a specially constructed barn ; and that, in spite of the additional expense of flue-curing, the net profit per acre is greater than that from indigenous tobaccos cured by the local method. Samples of leaf produced in the past season were sent to experts in England for valuation. They gave it as their opinion that the samples were the best they had seen so far of Indian growth, and that they resembled the corresponding American type. The third hybrid generation of crosses between American tobaccos and the best of the Pusa types (No. 28) has yielded 18 cultures which are most promising. The chemical effect of different methods of curing tobaccos on the composition of the leaf is under investigation in the Chemical Section at Pusa. It appears that the higher the destruction of starch in curing, the better the quality.

The acclimatization of exotic cigar and cigarette tobaccos and the improvement of the local races by selection are in progress at Burirhat in BENGAL. The cigar varieties imported from Sumatra and Manilla and grown on the farm have shown that cheroot tobacco of quite high quality can be produced in Bengal. The departmental selection Matihari, which has acquired the reputation of being the best *hookah* tobacco in the province, is now being grown in tracts which have not hitherto grown tobacco on a large scale. The superiority of Motihari over the local varieties is recognized in Assam too, and its cultivation is gaining ground. The other



A FIELD OF ADCOCK TOBACCO AT PUSA JUST BEFORE HARVEST COMMENCES.

PLATE III.



THE FLUE-CURING TOBACCO BARN AT PUSA SHOWING STRINGING AND LOADING IN PROGRESS.
(The two windows shown in the wall of the barn are not necessary.)

varieties under trial in this province are the Rangpur Bhengi and Pusa Type 28. The last mentioned variety has proved a definite success in North BIHAR, and a scheme for distribution of seed on a large scale is under consideration. Among the cigar varieties collected at Sa-aing in BURMA, Pennsylvania promises to prove the most suitable for general cultivation. It produces a good wrapper tobacco ; when coarser grown, it has a flavour suitable for filling. Gandiu No. 6 has established itself in the Upper Gujarat districts of BOMBAY. The high prices realized for the 1926-27 crop has given a great impetus to the cultivation of Virginian varieties (Adcock and White Burley) in the Guntur District of MADRAS, and the area under them is now estimated at 25,000 acres.

VIII. Oil-seeds.

The area of 21,526,000 acres under the principal varieties of oil-seeds, *viz.*, linseed, rape, mustard, castor, sesamum and groundnut, was larger than that of the previous year by over 10 per cent. There was a sympathetic rise in exports, which (including cotton and *mahua*) amounted to 1,210,000 tons valued at Rs. 26,69 lakhs —an increase of 44 per cent. in quantity and 40 per cent. in value over the preceding year's figures. Excluding castor seed, the exports represent on an average only 18 per cent. of the total outturn ; the balance of 82 per cent. is presumably crushed locally. But the oil-cakes produced are not all consumed in the country either as a cattle food or a manure, for we sent overseas during the year under report 276,000 tons of cakes valued at Rs. 314 lakhs.

Linseed. The United Provinces and Bihar between them carry half the total acreage under linseed, but the types grown are inferior as regards size of seed and oil-content to those grown in Peninsular India. As both classes also differ in their root-systems, hybridization is being employed at PUSA to produce a large-seeded race with vegetative and root systems suited to the soils of the Gangetic alluvium. The fourth hybrid generation under study contains many plants which appear to possess the desired characters. Of

the pure types originally selected from unit species, No. 12 has been adopted for demonstration in Assam where it gives a high yield of over 1,000 lb. per acre. A later selection called Type 124 has consistently maintained its superiority in oil-content over No. 12 during the past three seasons. Work on breeding a rust-resistant and higher yielding linseed has progressed in the UNITED PROVINCES to the extent that new strains will be available for a field trial next year.

Mustard. The selection of mustard is receiving attention in the Punjab, Bengal, Bihar and Orissa and Assam.

Castor. In Bombay, certain types of castor which, on account of the shape, size and colour of their seeds, are specially favoured by the trade, are being tested with a view to determining whether there are among them strains carrying the characters of high yield and high oil-content.

Sesamum. The isolation of unit species of sesamum was continued at PUSA. The change of the normal variety into the sepaloid form was almost absent during the past season; it indicates that this phenomenon may be due to physiological causes rather than to the segregation of characters and inheritance of genetic factors. A prolific type of sesamum known as Pyegyi has been isolated at Allanmyo in BURMA.

Ground-nut. This crop has, in recent years, assumed an economic importance of the first magnitude in some provinces. The area of 5,321,000 acres sown in the year under report was nearly four times as large as that in 1918-19; it has more than trebled in Madras in the same period, while the increase in Bombay is of over 500 per cent. In MADRAS, which carries nearly 63 per cent. of the total reported acreage under the crop, varietal and cultural experiments are in progress on a special farm at Palukuppam. The introduction of early varieties which do not require irrigation has given ground-nut the position of being the most important *kharif* oil-seed grown in the BOMBAY PRESIDENCY. Twenty years ago its cultivation was practically unknown in Upper Gujarat, Khandesh and Dharwar; the area in these three districts

is now in the neighbourhood of 4 lakhs of acres. As the export trade demands purity, the local department is making special efforts to ensure the cultivation of pure varieties. Ground-nut has invaded the cotton tracts of the CENTRAL PROVINCES too. It is grown there either in rotation with, or in place of cotton, and regular markets for the nuts are coming into being. Burma is another province where ground-nut cultivation has made great headway: within 20 years the area has increased to five lakhs of acres. In varietal tests at Allanmyo, the Imperial Spanish stood first in yield and the Small Japanese in oil-content. There is a great future for these short-season erect types as they do well even in light sandy soils. Ground-nut has become so popular on the poor soils of Chota Nagpur that questions relating to the marketing of the produce have arisen in some areas. The variety favoured is the early erect Kanke No. 17. Were it not for the damage done to the crop by pigs and other wild animals, it would be equally popular in South Bihar where large yields of this oil-seed are obtained by manuring with gypsum. In Mysore, where the area under the crop has increased from 77,000 to 250,000 acres in ten years, bunch and spreading types are being crossed with a view to segregating strains which, while retaining the special characteristics of the former, will have the vigour of the latter.

Coconut. The MADRAS department is demonstrating on 298 plots that coconuts can be raised under a dry system of cultivation, provided that deep ploughing is done in the first instance, the land bunded to catch all the showers, the soil kept constantly cultivated and a soil mulch maintained in the hot weather to conserve the soil moisture. Trees in several of the plots planted in 1924 have already begun to flower: this is a great advance over the local system under which trees are not expected to begin to bear till they are ten years old or more. As a result of these demonstrations lands which have hitherto lain waste are being planted up; over 13,000 seed-nuts and seedlings were sold for the purpose during the year. There are decided indications on the Government farms that coconut trees respond best to organic manures. The coconut caterpillar has been brought

fairly well under control in South Kanara by the introduction of parasites; the pest is, however, spreading in Malabar. Coconut gardens have been laid out on the Akyab and Kyaukpyu farms in BURMA, with a view to collecting data regarding the best method of cultivating the palm in Arakan.

IX. Tea.

Eighty-one per cent. of the total area under tea in India is in Assam and the two contiguous districts (Darjeeling and Jalpaiguri) of Northern Bengal. The area of 752,900 acres occupied by the tea bush during 1927 was nearly 2 per cent. larger than in the preceding year. Although the area plucked was also higher by 900 acres, the estimated yield of 390,920,000 lb. worked out at 562 lb. per acre plucked, as against 565 lb. in 1926. The largest decline in production was in Assam, where, owing to unfavourable climatic conditions, the yield was 6 million lb. less than in 1926. The tea industry had, however, another prosperous year; for, exports increased and prices throughout the season were well maintained. The exports by sea, amounting to 362 million lb. and valued at Rs. 32,48 lakhs, were higher than those of the previous year by 4 per cent. in quantity and 12 per cent. in value. In addition, nearly nine million lb. left the country by land. Less than eight per cent. of the crop was thus left in the country for local consumption.

The scientific staff of the Indian Tea Association continued to investigate problems relating to (1) the effect of manures, pruning and cultural operations on the yield, (2) the diseases and pests of the bush, (3) and the quality of the leaf as affected by the processes involved in its manufacture. Cultural experiments in progress at Borbhetta have supplied the evidence that so far as tea is concerned the major factor in cultivation is the suppression of weed growth and not the stirring of the soil. Careful pruning when supplemented by spraying with lime sulphur has been found to reduce the damage done by the red spider. In Southern India, the crop is dealt with by the scientific staff of the United Planters' Association. At the tea experiment station at Nellakotta, calcium

cyanide has proved an efficacious insecticide for the *Helopeltis* pest which is responsible for considerable loss in tea gardens.

X. Coffee.

The coffee industry in India is confined to a tract in Southern India, comprising part of the Madras Presidency, Coorg and the States of Mysore, Travancore and Cochin. The total area reported under the crop was 155,839 acres—an increase of 2 per cent. over that of the preceding year. The production of cured coffee was estimated at 317,539 cwt.; the exports amounting to 276,668 cwt. were valued at Rs. 232 lakhs. The variety of coffee ordinarily grown in India is Arabica. Kent's hybrid, having established its superiority both in yield and disease resistance at the Sidapur station of the United Planters' Association of Southern India, is now planted on a larger scale than any variety of Arabica. The work at the Balerhonnur station in Mysore was, during the year under review, practically confined to devising measures for the control of black rot and leaf diseases of coffee. It has been established quite definitely that the ravages of black rot can be almost completely controlled by spraying.

XI. Rubber.

Rubber is grown mainly in Southern India and Burma; in the year under review the area amounted to 151,841 acres which is 9 per cent. above that of the previous year. From the area of 104,694 acres tapped, 26 million lb. of raw rubber were obtained, as against 23 million lb. from 101,329 acres in 1926-27. Although the exports of 25 4 million lb. to foreign countries represented an increase of 10 per cent. in quantity, their value (Rs. 260 lakhs) was less by 3 lakhs of rupees than that of the previous year. The investigations carried out at the United Planters' Association's station at Aneikulum again tended to prove (*a*) that trees with latex tubes of below certain average bore are almost invariably poor yielders, and (*b*) that good yielding trees just as invariably possess latex tubes of above this average bore. As the characteristic tube bore can be differentiated early in the life of the plant,

potentially poor yielders can be detected when the plants are still in the nursery. The remarkable success of spraying in one of the worst years for secondary leaf-fall caused by the fungus *Phytophthora* has conclusively proved that the use of a smaller quantity of a very concentrated mixture is not as effective as $3\frac{1}{2}$ to 4 gallons of a more dilute mixture per tree, and that no spraying mixture is cheaper or more effective than Bordeaux mixture. Experiments have been undertaken to determine whether the change-over-system of tapping favoured in Ceylon has any advantages over the more common straight-out system in which one panel is completely tapped out before starting another.

XII. Fruit.

Although the cultivation of fruit on scientific lines has received but little attention in India, there are areas where the income of a number of cultivators is derived mainly from fruit. Even in the natural fruit-growing districts, the industry is carried on on primitive lines. Though, owing to shortage of staff, it has not been possible to give systematic attention to the problems of fruit culture, the isolated efforts made by a few officers of the Agricultural Department and by officers in charge of Government gardens to popularise better varieties of fruits and improved methods of cultivation, have given good results. The most notable success has been achieved in the North-West Frontier Province where the Agricultural Officer happens to be an expert in horticulture. Now that four other provinces have horticulturists on their agricultural staffs, fruit culture should receive the same systematic attention as has proved so fruitful in the case of the staple crops.

The cultivation of the superior varieties of plums, peaches, apricots and pears evolved on the Tarnab farm has now become firmly established in the Peshawar Valley: they are estimated to have occupied 3,000 acres during the year under review. The plums and peaches now offered for sale in the local markets are of very good quality. Over 13,000 fruit trees were issued from Tarnab during the year and a larger number was sold by private nurseries started by old employees of the farm. Nearly 5,000 plants were

issued during the year from the fruit station at Quetta in Baluchistan. The Horticultural Section of the Punjab Agricultural Department has been strengthened by the appointment of a second Fruit Specialist. In addition to the main nursery at Lyallpur, subsidiary ones have been started on three agricultural stations, and experimental orchards laid out at eight centres. The nurseries have been stocked with orange, mango and grape plants of authentic origin. A fruit preservation laboratory has been established with a view to investigating methods of converting surplus fruits into jams, jellies, marmalades, etc. Some of the Government gardens in the UNITED PROVINCES continued to propagate and distribute improved fruit plants.

In MADRAS, fruit gardens have been established at Coonoor, Burliar and Kallar with a view to encouraging fruit growing in the Nilgiris. Plums are a decided success at Coonoor, and sapotas at Kallar; while at Burliar a young litchi tree fruited for the first time and gave fruit of excellent quality. The use of wild stocks for budding citrus fruits is being investigated in Bombay: the most promising results have been obtained hitherto by using such hardy plants as *Feronia elephontium* and *Aegle marmalos*. The Horticulturist has also undertaken, through the process technically known as top-working, the improvement of the quality of the fruit given by mango trees growing in forests. Pomological gardens have been started on several agricultural stations in Burma. The Kew pineapple has demonstrated its superiority, in quality as well as in yield, over all other varieties tried at Hmawbi. It has done well, too, on sandy soil at Akyab. In Assam, experiments are being carried on by Mr. Holder who has taken a lease of the Shillong fruit farm from the Government. The grafted fruit trees of this orchard are in considerable demand in the province. Experiments on the storage of raw, half ripe and ripe mangoes have been undertaken at PUSA, in order to find out how far the ripening enzyme is affected by a low temperature.

The practice of spraying fruit trees with a view to protecting them against various diseases and insect pests is being adopted on an increasing scale.

XIII. Fodder Crops and Grasses.

In the past when cultivation was sparse and less intense, the cultivator relied very largely on Nature to provide food for his cattle in the form of pasture. In course of time most of these pasture lands have been ploughed up for providing food for the ever-increasing human population, but the growing of fodder crops as such has not been introduced in the routine farming practice. The cattle over a large part of India have therefore to subsist on fodder composed of stalks and leaves of over-ripe grain crops, supplemented by a certain amount of stubble-grazing. A diet of such small nutritive value which again is hardly sufficient in quantity for even half the year, is one of the principal contributory causes towards the deterioration of the bovine population of India, and the work done for their improvement will not bear full fruit until and unless the Indian cultivator is taught to make better provision for feeding them. If cattle-owners could be induced to grow fodder crops and to store fodder in the green state in silo pits, or in stacks or barns after drying, as is done on Government farms, they would be secured to some extent against fodder famines which are one of the great barriers to steady progress, not only in cattle-breeding but in agriculture generally.

The most valuable leguminous fodder crop introduced by the Agricultural Department is Egyptian clover or berseem. It is now being grown successfully in Bihar, Sind, the Central Provinces, the Punjab and the North-West Frontier Province. At PUSA, a large area of irrigated land is laid down to berseem every year, after which a second crop of early maize is raised. The berseem is mostly grazed by tethering the dairy cattle in the field. This system of growing clover for soiling has converted what was formerly rough sandy jungle which even now remains flooded during the monsoon months, into the richest land on the farm. By thus cropping a comparatively small irrigated area which was previously waste land, a large herd is provided with luscious green fodder for the greater part of the year. The abundance of berseem available in the winter and summer months largely accounts for the fact that



PLATE V.

BERSEEM CROP READY FOR CUTTING AT PUSA.

LIBRARY OF THE ROYAL ASIATIC ... BOMBAY BRANCH

the average milk yield of the dairy herd during that period exceeds that in the monsoon by over a couple of pounds per cow per day despite the fact that during the rains, too, the herd is grazed on fields of *kharif* pulses such as *guar* (*Cyamopsis psoralioides*) and *meth* (*Phaseolus aconitifolius*).

Among the new fodders introduced in BIHAR AND ORISSA, Rata grass (*Anthistiria ciliata*) and soybeans are the most promising. Perennial fodders like Elephant grass and Guinea grass are being popularised in parts of ASSAM ; the demand from cattle-owners for clumps of these grasses for planting is being met from the Jorhat farm. On the Mandalay farm in BURMA, berseem when broadcasted in standing paddy crop gave a good crop and produced a certain amount of seed. The yielding capacity of various varieties of grasses, turnips, leguminous fodders and fodder *juars* is being studied by the Fodder Specialist of the Punjab Agricultural Department. Sudan grass gave, during a period of $4\frac{1}{2}$ months, $1\frac{1}{2}$ times the amount of fodder yielded by the fodder *juars* with which it was compared. With liberal applications of manure and water, Elephant grass has been found to give over 90 tons of green fodder per acre per annum. *Kutcha* silo pits filled with shredded *juar* were opened after two years at Hissar ; the fodder came out in perfect condition and was much relished by stock. Since it was first introduced on the Tarnab farm in 1911, berseem has replaced shaftal (Persian clover) on 12,000 acres in the North-West Frontier Province where clover is grown in every irrigated field once in three years.

Methods of renovating poor pastures are under investigation in Bombay. A considerable improvement both in the yield and quality of grass has resulted in two fairly large forest areas placed under rotational grazing. In an experimental area on the sea coast, the yield of grass increased phenomenally when the first growth was turned into silage and the second growth cut or grazed or both. The other studies in progress are the life-history, ecology and the feeding value of spear grass (*Andropogon contortus*), the relation of grass species to soil moisture and the effects of burning. In

Madras, *Paspalum dilatatum* has proved particularly suitable for the hills, while at Hosur Kolukattai grass has done better than any other under trial. There was a loss of only 17·5 per cent. on the green weight in one lot of *juar* siloed at Coimbatore ; it amounted to 67 per cent. in the case of *juar* made into *kadbi*.

XIV. Millets.

Juar (*Andropogon Sorghum*), *bajri* (*Pennisetum typhoideum*) and *ragi* (*Eleusine coracana*) are the principal millets cultivated in India. Of these, *juar* is the most important. The principal *juar*-growing tracts are in Bombay, Madras, the Central Provinces and Hyderabad where the grain forms the staple diet of a large section of the population and the dry stem (*kadbi*) a useful cattle food. In other provinces, it is mainly grown for its fodder. *Bajri* and *ragi* occupy on an average 14 and 4 million acres, respectively, in British India.

In Bombay, improved grains of *kharif juar* have been obtained by selection at Dharwar, Surat and Larkana, and strains of *rabi juar* at Broach. The system of growing *juar* on ridges is being widely adopted in South Gujarat. The average increase of yield from ridge cultivation is reported to be over 20 per cent., and the method is applicable to lakhs of acres of black soil on which *juar* suffers at present from water-logging. The selected *juars* under distribution in the Central Provinces are the yellow-grained Saoner, Dhamna, Detha and Lamkansi, and the white-grained Ramkel. Types 1 and 6 are doing well in Madras in the restricted localities to which they are suited.

As the result of departmental propaganda, *juar* seed is now treated on a large scale in some parts of India, with a solution of copper sulphate to prevent an attack of smut. The practice of dusting *juar* seed with copper carbonate is being introduced in the Central Provinces, as the seed treated in this way does not lose its vitality when stored.

Seventy-two per cent. of the total acreage (67 lakhs) under *ragi* is in Madras and Mysore. In the latter State, where *ragi* is the premier cereal crop, H. 22 isolated on the Hebbal farm has established

itself over nearly a lakh of acres. Some types superior to H.22 in yield have recently been isolated, but they suffer from the disability of late maturity. The Millets Specialist in Madras has obtained a superior strain of *ragi* (E. C. 47), seed of which will be distributed this year in the district round Coimbatore. Breeding work on *ragi* is in progress in Bombay at a special station in the uplands of the Konkan where *ragi* is the principal food crop.

XV. Other Cereals.

Maize. Of the area of nearly 6 million acres under maize, 60 per cent. is in the United Provinces, the Punjab and Bihar and Orissa. The variety adopted for distribution in the first named province is the one known as Jaunpur ; it is also finding favour in North BIHAR. A very early maize suitable for the *diaras* of South Bihar seems to have been found in a variety called Tinpakhia recently selected at Sabour. Yields of 20 cwt. of grain per acre have been obtained on the Sepaya farm by growing maize in lines wide enough apart to permit intercultivation and ridging. This system of growing maize is applicable to large areas in the Saran District which, though somewhat low-lying for upland crops, are very precarious for paddy. The Kalimpong maize isolated on the farm of that name now occupies a large proportion of the total area under the crop in the district. It has done well at Khurda, too, and promises to become popular in ORISSA. Selection work in progress at PUSA has given a yellow-seeded and a white-seeded type both of which are promising.

Barley. Over 63 per cent. of the total area under barley is in the United Provinces where several strains of high malting value have been isolated. Barley-breeding is also receiving attention in the Punjab and at Pusa.

Oats. In the Botanical Section at PUSA, two types of oats have been isolated which have proved superior in yield to the best varieties hitherto grown on the farm. If these selections which are to be known as B. S. Types 1 and 2, maintain their reputation in large-scale field trials in the 1929 season, they will be released for seed distribution purposes. The F_2 generation of two crosses made

between the Scotch Potato oat and two Pusa selections has given some very promising hybrids. The good grain and straw quality together with the heavy tillering power of the imported varieties have been combined with the earliness and disease resistance of he Indian parent. It has incidentally been proved that the cultivated oats in India belong to the species *Avena sterilis* Linn., subspecies *culta*, and not *A. sativa* Linn., as has hitherto been believed and reported in all important floras and other books of reference.

XVI. Potatoes.

The potato crop is steadily increasing in popularity, but any rapid extension of the area under this tuber is handicapped by the difficulty experienced in obtaining disease-free seed. The problem of disease control, both in the field and during storage, is being tackled in several provinces.

In ASSAM, the work of acclimatizing, testing and distributing potato seed is being carried out on the Upper Shillong Farm. Among the 25 varieties under trial, King-of-Potatoes stood first with Arran Chief a close second. The highest yield was obtained in a plot manured at the rate of 5·5 tons of cowdung, 822 lb. oil-cake and 200 lb. superphosphate per acre. Though the seed of the varieties tested on the farm is much in demand, the older selections are showing distinct signs of degeneration. Steps are therefore being taken to import fresh seed. The experiments carried out in the departmental cold store at CAWNPORE have proved that it is possible to carry potatoes through the hot weather without much loss. Scotch potatoes introduced in the SIMLA HILLS have given a return of Rs. 84 per acre more than the local varieties. The effect of underground storage in reducing losses from disease is being tested at Lyallpur. The problems of potato cultivation in the NILGIRIS are under investigation at a special farm at Nanjanad. Deep cultivation and heavy dressings of organic manures have been ascertained to be essential for assuring bumber crops. Potato cultivation is spreading rapidly in the Southern SHAN STATES : exports to India are now valued at Rs. 25 lakhs as compared with Rs. 3 lakhs before the Great War.

XVII. Beans and Pulses.

In Burma, three Lima BEANS called Moki Lima, Sieva Pole and Lewis are being tested with a view to finding a substitute for the Burma bean (*Phaseolus lunatus*) : the export trade in the latter bean has fallen off on account of the prussic acid scare. The earliest imported Moki Lima has been found to hold its own in yield with the white Pebyugale but not with the coloured Pegya. An effort is being made to evolve a strain which will surpass Pegya in yield on the poorer soils of the uplands. The introduction of the wilt-resistant Karachi GRAM has given a great impetus to the cultivation of the crop in Burma. In the 10 years previous to its first distribution in 1921, gram occupied on an average 53,000 acres ; the area during the year under review was estimated at 267,000 acres. Gram Type 4 isolated at Sabour has proved suitable for South-East Bihar but especially for the *diaras* (alluvial lands subject to inundation) ; the demand for seed exceeds the supply. Pusa Type 17 having given the largest yield in the varietal trials on the Sepaya farm, is to be propagated for general distribution in North Bihar. The inheritance of qualitative and quantitative characters is under study at Pusa among crosses made between some of the 25 pure strains of grams isolated there.

Breeding work on PIGEON-PEA is in progress at Pusa, Sabour and Mandalay. The behaviour of the several types isolated at Pusa for wilt resistance has thrown considerable light on the correlation between the presence of certain morphological characters and the possession of resistance. It also appears that the morphological differences between types are correlated with physiological differences in their metabolism. At Sabour, two types—one spreading and the other erect—promise to meet the varying needs of the province. Some of the pure strains isolated in Burma mature about 50-60 days earlier than the mixtures ordinarily grown. Other pulses under improvement at Pusa and at some of the provincial agricultural stations are *Phaseolus mungo*, *P. radiatus* and *Lens esculenta*.

CHAPTER III.

RESEARCH AND INVESTIGATION.

In addition to the economic work on crops detailed in the previous chapter, a considerable amount of research work bearing on fundamental problems of agricultural chemistry, agricultural bacteriology, plant pathology, mycology and entomology is being done by some of the departments of agriculture in India. Among the investigations in progress during the year may be mentioned those dealing with the lime requirements of soils, the reclamation of saline lands, the conservation of soil moisture, the fixation of nitrogen, the manufacture of artificial farmyard manure, the nitrification of manures in the soil, the utilization of the sources of natural indigenous phosphate, the detection of adulterants in *ghee* (clarified butter), animal nutrition, the mosaic disease of sugarcane, and the control of pests infesting food-grains. Although much light has already been thrown on the problems under investigation, it is yet too early to base definite recommendations on the data collected. Some of the outstanding results are briefly noted below; but for detailed information relating to the research and investigational work in progress, reference may be made to scientific reports of the Pusa Institute and to those of provincial research officers.

I. Soils.

Survey of soils. Soil surveys of typical tracts continue to be carried out by several departments. In MADRAS, a soil survey of South Malabar has been completed. The soils of this area appear to be well supplied with nitrogen and potash, but deficient in lime and phosphoric acid. Soil surveys of the Pegu and Mandalay Districts in BURMA were sufficiently advanced to indicate the areas where the soil constituents are deficient. In connection with an investigation into the incidence of goitre in rural areas, a survey of the calcium carbonate content of typical soils from all tehsils of six districts of the UNITED PROVINCES was carried out. In ASSAM,

a soil survey of the Jorhat sub-division is in progress, in which particular attention is being paid to variations in soil acidity. The soil survey of the Travancore State has been extended to the Shertalli Taluq where a deficiency in lime and phosphoric acid has been noticed.

Soil acidity. Work on laterite soils and the cause of acidity is being continued at PUSA. Incidentally it has been observed that a rod of pure antimony dipped into moist soil develops an electric potential proportional to the pH value, and that it is eminently suited for use in determining the lime requirements of soils. Based on this observation, a portable apparatus has been designed for employment in the field. Conditions governing the growth of rice in acid laterite soils are under investigation at Dacca in BENGAL. Field experiments laid down to study the effect of liming indicate that an increase of nearly 3 cwt. of grain is obtained when lime is applied under optimum conditions. In ASSAM, acidity greater than pH4 has been found toxic to rice seedlings: root development is poor at values below pH6 and is highest at pH8. The Scientific Department of the Indian Tea Association have determined that, if other conditions are favourable, good tea soils give pH values ranging from 4·0 to 4·6, and that higher figures indicate a distinct need of acid manures. Among the commoner manures used, sulphate of ammonia alone caused a significant increase in acidity.

Soil moisture. Methods of conserving soil moisture in tracts of scanty rainfall are under investigation in Bombay, Madras and the Punjab.

Reclamation of soils. The possibility of reclaiming about 300,000 acres of *bara* (saline) lands in the Montgomery District of the PUNJAB is under investigation at a special station at Harappa Road. The keeping of such lands continuously under water for a period of two or more months has produced more promising results than any other method of reclamation attempted. Generally speaking, flooding has been most effective in the case of soils treated with gypsum.

With a view to devising methods for the reclamation of the less toxic types of *usar* common in the UNITED PROVINCES, the seasonal variation of the bacterial and fungal flora of such soils in their relation to nitrification processes is being studied.

II. Nitrogen Fixation.

An investigation into the fluctuations in the total nitrogen content of different plots under permanent manurial experiments at Pusa has shown that the soil of plot No. 16A which was manured with green manure and superphosphate contains the largest amount of nitrogen. The soil of the fields in which Egyptian clover and maize were grown in rotation without manure were found to contain twice as much nitrogen as that of the plots in the experimental area. Laboratory experiments on nitrogen fixation have definitely shown that algæ fix a certain amount of nitrogen in soils. A full year's study of the factors affecting the seasonal contribution of canal water to soil fertility at Lyallpur has shown that nitrifying and nitrogen-fixing bacteria are more frequent in the summer than in the winter, and that organic and nitric nitrogen are present in canal water in appreciable quantities.

III. Manures and Fertilizers.

The ryot generally uses cowdung as a fuel rather than as a manure, whilst large quantities of oil-seeds, oil-cakes and bones are exported. Were it not for the recuperative effects of natural processes in the soil which are fortunately very pronounced in tropical and sub-tropical regions, Indian soils would not be producing even the comparatively poor crops they are doing to-day. India can no longer rely on being able to go on feeding her ever-growing population on the present scheme of farming, which depends upon getting a continuous series of crops, the yields of which are so low that they do not exhaust the soil. Production must be intensified, but this cannot be done without an extended and judicious use of manures. The introduction of improved varieties of crops will not in itself solve the problem ; the fullest advantage of such varieties cannot be secured until and unless their introduction is accompanied by liberal

manuring. The custom of using cattle dung as a fuel cannot perhaps be changed in a generation ; nor is it to be expected that the simple expedient of a high export duty on oil-seeds, bones and fish manures will materially contribute towards the larger application of these valuable manures. The work of the Agricultural Department during recent years has, however, shown that vast amounts of very valuable organic matter, in no way inferior to farmyard manure, can be prepared from waste products by the simple process of composting. At any time in the year, the whole countryside is littered with refuse of all kinds and if this is utilized in accordance with the methods devised on Government farms, thousands of tons of organic matter will be available at a comparatively trifling cost. By reinforcing this organic matter with artificial fertilizers, much larger areas than is done at present could be manured. Some of the new brands of the latter now on the market are particularly suitable for Indian soils, and their prices have been fixed at a level which makes their use profitable for certain crops.

Organic manures. The possibilities of adding to the manurial resources of the country by producing ARTIFICIAL FARMYARD MANURE by composting waste products are under investigation at several centres. Success has been achieved at Coimbatore in converting such materials as sorghum stubble, gram stalks, prickly pear, etc., into manure of excellent composition. In field trials, it proved to be as valuable a manure as ordinary village cattle manure prepared by the loose box method. Plantain stems are being successfully utilized in Bombay for the manufacture of synthetic manure. In Travancore, the addition of bonemeal to the cattle dung emulsion used as a starter enriched the resulting product in its phosphoric acid content, and accelerated the rate of decomposition. Large quantities of artificial farmyard manure were prepared during the year at Dacca and other agricultural stations in Bengal from refuse straw, sugarcane trash and weeds, to which were added cattle urine, byre washings and a little bone-meal. Equally good results were obtained by substituting sulphate of ammonia for urine, and by using phosphate of ammonia in place of urine and bonemeal.

Investigations connected with the use of GREEN MANURE are in progress in many parts of the United Provinces. At Shahjahanpur the effect of ploughing in sann-hemp grown on soil which would have otherwise lain fallow in the rains was noticeable as soon as the sugarcane germinated. Germination was more uniform ; the young plant grew more vigorously and developed a larger leaf surface. With a view to encouraging the practice of growing green-manure crops, the Local Government has decided to supply water for such crops at reduced rates of one rupee per acre for flow and eight annas for lift irrigation. • At Pusa sann-hemp cut on 1st August and applied after one month's fermentation benefited the oat crop to a greater extent than that applied in a fresh state or after a longer period of fermentation.

The availability of the nitrogen of different OIL-CAKES and other nitrogenous manures is being investigated at Coimbatore. Nitrification has been found to be more rapid in black cotton soil than in red soil. That the addition of charcoal to *mahua* (*Basia latifolia*) cake composts decidedly increases their manurial value, has been confirmed at Pusa in field tests carried out with wheat.

Nitrate of soda. Experiments conducted at Coimbatore to test the effect of sodium nitrate on paddy indicate that it is largely physical. In Bombay it has given good results when applied to onions.

Phosphates. Work on the utilization of the natural sulphur-oxidizing power of certain soil bacteria for the solubilization of the phosphoric acid of bonemeal by composting was continued at Pusa. In field trials carried out simultaneously at Pusa, Netarhat (Chota Nagpur) and Aligarh (United Provinces), a compost of bonemeal, sulphur, sand and charcoal gave higher yields of potatoes than either bonemeal or superphosphate. Its superiority was equally well marked in plots carrying crops of wheat and onion. In Travancore, 63 per cent. of the insoluble phosphoric acid was rendered soluble even when crushed bones were used for composting. Trichinopoly phosphate resisted solubilization at Coimbatore until organic matter was added.

Ammophos (20-20 grade) and Leunaphos when applied in so small a dose as 80 lb. per acre increased the yield of paddy by 492 lb. in South Bihar and gave a net profit of Rs. 21 per acre. In Orissa, Ammophos is the only phosphatic manure which has so far given satisfactory results with rice. At Hmawbi and Mandalay in Burma, the optimum dose of Ammophos (20-20 grade) has been ascertained to be 200 lb. per acre of paddy. The net profit in the year of application is about Rs. 24 per acre ; in the succeeding year the residual value of the manure is about Rs. 12.

IV. Silage.

A bacteriological study of the changes occurring during the preparation of silage is in progress at Pusa. It has been noticed that silage made early in the monsoon from maize containing a high percentage of moisture, does not develop acidity so rapidly as that made from maize of a later growth. When there is a good development of acidity in the first five days the silage is very good. In sorghum silage the acidity is slower in developing than in maize silage, and the former is far more liable to have a putrefactive odour.

V. Animal Nutrition.

In feeding experiments on the nutrition of growing animals at the Imperial Institute of Animal Husbandry and Dairying at BANGALORE, spear grass silage combined with even a low allowance of concentrated food gave a higher increase in weight than spear grass hay or *ragi* (*Eleusine coracana*) straw combined with a high allowance of concentrates. Of the three breeds of cattle under trial, *viz.*, the Scindi, the Ongole and the Kangayam, the Scindi did best. Feeding tests with coarse fodders have shown that the higher the protein allowance the lower the digestion of the total carbohydrate and organic matter, though very striking differences were not noticeable. In experiments designed to determine the relation between the digestive capacity and the milk yield of different breeds of milch cows, cross-bred cows consumed 50 per cent. more food than Scindi cows. Scindi cows on going dry consumed less

food : this was not noticeable in the case of cross-breds. When the concentrate was reduced, the latter kept up their food consumption by eating more roughage. Observations on diuresis were continued and the work has been extended with a view to studying certain important characteristics of cattle urine.

Feeding trials carried out at LYALLPUR with grass hays obtained from different military grass farms have shown that the feeding value of a hay depends upon the types of grass composing it, the time of cutting, the season, etc., rather than upon whether it was grown on the hills or in the plains. In another experiment carried out, the seed of the Punjab-American cotton No. 285 was found to be 50 per cent. richer in digestible proteins and other ingredients than that of *desi* varieties. The enquiry into the food values of natural pastures is nearing completion.

VI. Sugarcane.

The investigation into the effect of different manurial constituents on the quality of sugarcane juice and *gur* was extended at PUSA to various combinations of manures. The canes manured with potash and superphosphate yielded juices of the highest quality, though the yield was markedly low. From the point of view of yield, the best combination was superphosphate and sulphate of ammonia. The effect of frost on the ripening of sugarcanes is under investigation in the PUNJAB.

An improved method of manufacturing vinegar from cane juice, *gur*, molasses, etc., has been worked out at PUSA. This process gives a product with a concentration of 6 to 7 per cent. acetic acid.

VII. Milk and Milk Products.

The analysis of the milk of selected cows of the Pusa herd has shown a gradual rise in the fat content with the progress of the lactation period. It has also been observed that each individual cow tends to give milk of similar fat content in her different lactations. Bacteriological examinations of the milk supplied from the Pusa dairy have shown that the plate counts are highest in September and lowest in February ; that the use of covered pails tends to lower

the counts very much, especially when the temperature is low; that the bacterial content of milk from different cows varies to a great extent, and that the first drawn milk contains five to six times the number of bacteria present in that obtained during the middle of the milking operation.

A yeast isolated from a sample of spoilt milk from the Karnal dairy has been found at Pusa to ferment the lactose of milk into alcohol and carbon dioxide. The organism is similar to *Torula lactis* and might prove of some economic importance in the conversion into alcohol of whey which is at present thrown away after the separation of casein used in the preparation of Bengal sweets.

The acetic ether test evolved at Pusa for the detection of the adulteration of butter and *ghee* by animal fat, has been found effective for all cow butters and for buffalo butters made from the milk of animals not fed on cotton seed. In the case of butter made from the milk of buffaloes fed on cotton seed, Halphen's test should be applied and if a positive result is obtained, a slight modification of the proportions of acetic ether and alcohol permits of a reliable deduction being made. The test, however, does not seem to apply when the object is to detect adulteration with " vegetable fat."

VIII. Diseases of Crops.

The practical methods adopted for combating the ravages of the diseases attacking the more important crops have been indicated in the previous chapter. It is proposed to deal here with such investigations as have not yet reached the stage of practical application.

The record of pigeon-pea wilt in the manurial plots at Pusa seems to suggest that the application of superphosphate stimulates the disease, that green manure is unfavourable to it, and that when both are applied they have an effect intermediate between the two applied singly.

A further survey made at Pusa of the diseases prevalent on sugarcane-growing stations in different parts of India has revealed

the presence of mosaic disease in many varieties not previously mentioned. The amount of mosaic on the Coimbatore seedling canes has been found to be small in North Bihar and comparatively small throughout North India where a percentage of even 15 is rare. Observations made on the Pusa farm itself indicate that Co. 205 is very susceptible to this disease ; Co. 250, 287 and 213 are fairly susceptible ; Co. 210, 273, 275, 281, 282, 286, and 288 are resistant ; and Co. 214, 248, 270, 280 and 290 are highly resistant. In cane fields on seven estates in North Bihar, Co. 205, 210 and 213 were found to be less affected than Hemja which they are gradually replacing. Roguing carried out in the last two seasons has reduced the incidence of disease to below 0·5 per cent. in every case except in that of Co. 205. In the tropical parts of India such as Lower Burma, however, the two Coimbatore canes tried, *viz.*, Co. 213 and Co. 210, are fully infected. Thick canes are much more heavily attacked by mosaic, percentages up to 100 being not infrequent.

Field work carried out during the year showed that each of the two methods worked out in the laboratory of preventing smut in Kodon (*Paspalum scrobiculatum*), *viz.*, (1) by steeping the seed in copper sulphate, and (2) by dusting it with copper carbonate, was effective in reducing the amount of disease from about 50 per cent. to less than one per cent. The loose smut of wheat has been almost entirely eradicated from the Lyallpur farm in the PUNJAB by steeping the seed in hot water. It has been ascertained in BURMA that in the case of the Kunpyaung variety of sorghum in which the glumes adhere closely to the seed, the soaking of seed in a 2 per cent. solution of copper sulphate for 15 minutes does not give complete protection from grain smut.

Piricularia oryzæ, the fungus which causes *Blast* of paddy, is under study at Coimbatore in MADRAS. It appears that there is a wide range of variation in resistance among different varieties of rice ; that the relative resistance of the varieties under trial is fairly constant ; that late varieties are on the whole more affected than early ones, and that potash and phosphatic manures individually have some inhibitory influence on the disease. Of the three spraying materials under trial, Bordeaux mixture is the most effective

in checking the *pollu* disease and the shedding of spikes in pepper vines.

Further investigations carried out in the CENTRAL PROVINCES are reported to have corroborated the view that the disease known as wilt of cotton is of physiological rather than of fungoid origin.

IX. Insect Pests.

The measures adopted against important pests of field and garden crops have been referred to elsewhere and need no recapitulation. A large number of useful observations relating both to the behaviour of insects known to affect crops and to their parasites, has been made at Pusa and in the provinces. These are referred to below.

The study of *Pseudococcus* spp., *Aphis sacchari*, *Pyrilla* spp *Assamia moesta* and *Neomaskellia bergii* at PUSA has shown that none of these sucking insects is concerned with the transmission of the mosaic and streak diseases of sugarcane. *Aphis maidis*, which is believed to cause mosaic in other countries, has, however, been found to occur at Pusa on maize and sorghum. Work on cane-borers and their parasites was continued. A study of the habits and life-history of the Braconid which is parasitic on the adult weevils of *Myllocerus 11-pustulatus* var. *maculosus* attacking cotton plants has shown that the adult parasites are active at Pusa till early April and do not disappear after the first week of February as hitherto believed. Another year's work on the storage of wheat under mercury vapour has definitely proved that the method is quite satisfactory for household purposes. Mercury, while effectively protecting wheat against the ravages of *Sitophilus oryzæ*, does not adversely affect either its germinating capacity or its food value. Bruchid beetles do not attack gram in the presence of mercury, and when gram already infested with Bruchids is stored with mercury, all further breeding of the pest ceases. The fumigation of wheat and sorghum with a dose of 1·2 ounce of carbon disulphide in 17 cubic feet of air space proved effective at Lyallpur against all insects and did not impair the germinating capacity of the grain.

The paddy stem weevil (*Schœnobius incertellus*), the sorghum fly (*Calocoris angustus*), mango hoppers and fruit flies are under

study in MADRAS. Particular attention was devoted to finding out how the first mentioned pest tides over the interval between succeeding crops. There appears to be a relationship between the existence of wild paddy and the degree of infestation, and there is undoubtedly a heavier attack in lands on which the second crop of one year overlaps the first crop of the succeeding one.

Research work in progress in BOMBAY has shown that the caterpillar of the spotted bollworm of cotton cannot pass down into the soil to pupate if the latter is effectively mulched. The investigation of the pink bollworm attack, which is responsible for the loss of 20-40 per cent. of the cotton crop in the UNITED PROVINCES, continued to be the main work of the provincial Entomologist. Large-scale field experiments with heat-treated seed were undertaken at three centres, and though the results were masked to some extent by adverse weather conditions, 50 per cent. more marketable *kapas* (seed-cotton) was obtained than from untreated areas. Valuable information obtained on flight infection during the year has led to the conclusion that, in order to protect three-quarters of the area treated in a continuous cotton-growing district from serious reinfection by flight, a compact controlled area extending for at least 30 miles radius from the centre will be required. Experiments on the control of the spotted and pink bollworms of cotton are also in progress in the PUNJAB.

X. Useful Insects.

Apiculture. The Entomological Section at Pusa continued to deal with enquiries relating to apiculture and to supply improved hives, foundation combs and queen excluders. Work on bee-keeping has been started by the Mysore Department of Agriculture; a number of improved hives were distributed during the year among coffee planters who have begun to take an interest in this subsidiary industry.

Lac culture. At the Lac Research Institute at Ranchi, a study of the life of the female lac insect has shown that, contrary to the general opinion, the mother insect is alive at the time of swarming, and can, to a certain extent, control this phenomenon during

unfavourable conditions. It has also been conclusively proved that lunar periodicity is not in any way connected with larval swarming. Observations on the predators and parasites on the lac insect were continued, particular attention being paid to the life-history and seasonal appearance of the Noctuid moth (*Eublemma amabilis*) which is responsible for considerable damage. The influence of manures on the output of resin is being investigated in field experiments which were started two years ago. In the amounts of alcohol-soluble resin and wax as in the output of lac, the limed and unlimed plots receiving full manurial treatment have shown higher maxima than the unmanured plots. It has been ascertained, too, that the ether-soluble portion always reaches a higher maximum in limed plots than in unlimed ones. A bio-chemical investigation of the food constituents of host trees at various stages is being carried out, and the insolubles in lac and shellac and the physical properties of shellac solutions are being studied.

Sericulture. In Bengal, 12 nurseries are maintained for supplying disease-free seed of the Nistari and Chotopolu races of mulberry silkworms. Over 500 demonstrations of improved sericultural practice were given in Malda, and five new village associations were organized, the members of which have undertaken, *inter alia*, to use only departmental disease-free seed and to report outbreaks of disease to the nearest departmental officer.

The introduction of ericulture among the agriculturists is making rapid progress particularly in ORISSA.

The hybrid worms obtained at Coonoor in MADRAS by crossing the univoltine French with the multivoltine Mysore worm are in the thirteenth generation; the seeds distributed from the eleventh generation have given good results.

In the PUNJAB, 1,963 oz. of silk seed were distributed amongst 992 rearers in 183 villages, and 203 schools were supplied with selected seed. The filature started at Sujanpur with a view to helping the rearers to obtain a fair price for their produce, reeled nearly 14 cwt. of silk yarn. Seven new mulberry plantations containing 13,700 trees were established and 31,400 seedlings and cuttings distributed among private persons and schools.

Over 26,000 seed cocoons, 10 layings of eggs and seven tons mulberry cuttings were distributed from the Maymyo nursery in BURMA. Another nursery was opened during the year at Paukkaung in the Prome District.

Of nearly seven lakhs of disease-free layings issued from four State grainages in MYSORE, over two lakhs were hybrids. With a view to meeting the whole of the growing demand for selected seed, it has been decided to subsidize private grainages run on approved lines: two qualified persons took advantage of the offer in the year under review. The number of selected rearers working under departmental control rose from 75 to 132; they produced nearly ten million seed-cocoons. The State filature produced 27 cwt. of silk and 18 cwt. of silk waste.

CHAPTER IV.

AGRICULTURAL ENGINEERING.

Except in the submontane tracts of the Himalayas, East Bengal, Assam, Lower Burma and the narrow strip between the Western Ghats and the Arabian Sea, the absolute security of the harvest throughout India depends on the existence of some form of irrigation. Government have provided at the cost of over 100 crores of rupees irrigation works which protect 26 of the 256 million acres under cultivation in British India. From time immemorial the cultivators have also sought to supplement and conserve the rainfall by the construction of wells and storage reservoirs and by bunding streams. Of some 24 million acres thus protected through private effort, $16\frac{3}{4}$ million acres are dependent on **lift irrigation** from wells and other sources such as rivers and nullahs. To the Engineering Sections of the Agricultural Department has been assigned the task of increasing the capacity of the existing wells, of digging or sinking new ones, and of providing improved methods of lifting water, particularly by substituting power pumps for water-lifts driven by bullock or man power. The staff available for this class of work has hitherto been lamentably inadequate; but, as will be gathered from Appendix IV (p. 120), some useful work is being done in increasing the controllable water supply.

In BOMBAY, 312 bores were put down by the department in the year under review, of which 181 were successful. The respective figures for the previous year were 193 and 113. The staff employed by the department for land development work prepared 89 schemes for field embankments. In the UNITED PROVINCES, 73 tube-wells, as against 65 in 1926-27, were completed, and 105 were under construction on the last day of the year. Thirty-six tube-wells were equipped with power pumping plants. Of the 939 shallow borings made, 699 or 74 per cent. were successful. Seven hundred and twenty-five wells were bored in the PUNJAB, as compared with 584 in the previous year; the percentage of successes also rose from

81·5 to 83·8. Of the 410 strainers installed, 408 were of the stoneware pattern designed by the Agricultural Engineer. Two artesian wells and one tube-well were completed during the year. The latter is fitted with a stoneware strainer and is giving a discharge of 35,000 gallons per hour under a very small depression head. In BIHAR AND ORISSA, 290 new wells were bored, 47 old borings were cleaned and relined, and twelve tube-wells were sunk. For the smaller tube-wells and for ordinary wells in which bores have been put down, the *rahat* (Persian wheel) bullock pump is steadily gaining in popularity : 37 such pumps were installed during the year. A smaller size *rahat* has more recently been designed which costs Rs. 175, discharges 2,500 gallons per hour and is capable of being worked by a single bullock on a 20 ft. lift or by a pair of bullocks on greater lifts. A number of *bandhing* schemes were carried out both in Chota Nagpur and South Bhagalpur. In the latter tract alone, 16 schemes designed to irrigate some 9,000 acres and to cost about Rs. 89,000 have been taken in hand by the owners assisted by the Department of Agriculture. Five hundred and seventy-two wells were successfully bored in MADRAS by the Industries Department to whom this work is entrusted. All the 28 bores undertaken in BENGAL were successful. In HYDERABAD and BARODA States, 43 and 32 new wells, respectively, were bored.

The designing of **improved implements** has not yet received attention to the extent the importance of the subject deserves, because when agricultural engineers were appointed to certain provinces late in the day, they found it necessary to give almost all their time to work connected with boring and pumping operations. Such improved types as have been introduced were evolved by enthusiastic Deputy Directors of Agriculture who were anxious to get a move on. Of the agricultural implements common to India, the most important is the plough of which the best types in use in India to-day are those designed by the firm of Ransomes, Sims and Jefferies. This enterprising firm sent engineers to this country who after studying local conditions, in company with Deputy Directors, designed such ploughs as the " Turnwrest," the " Sabul," and the " Monsoon " which are now being used on a fairly large

scale as will be gathered from Appendix V (p. 121). The success of this firm gives one reason to believe that well qualified agricultural engineers, if employed by Departments of Agriculture for such work, could accomplish much in a reasonable time. It is satisfactory to note in this connection that Bengal and Madras each recruited an Agricultural Engineer during the year under review. When a small number of types of implements suitable for a wide range of conditions is evolved, the question of mass production will, no doubt, be considered. It may be found necessary in the interest of economy to import from the West, where their manufacture is better understood, the more elaborate steel and iron parts, such as the mould-board and the share in the case of the plough. If the wooden or iron frame work can be made satisfactorily and more cheaply in India, it should be possible to reduce the cost of the whole implement by manufacturing them here on a mass production basis. The demand for improved implements is small because they are dear: they are dear because the demand is small. If good serviceable implements were to be placed on the market at prices within the means of the cultivator, and if the worn and broken parts could be replaced at a small cost as a result of all spare parts being standardized and simplified, a large demand would almost certainly spring up for ploughs as well as for drills, fodder cutters, threshers, winnowing machines and small power cane mills.

In BOMBAY, the efforts of the Agricultural Engineer towards the improvement of the indigenous seed-drill have achieved considerable success. The new drill designed by him can be worked by a man and a pair of bullocks, as against a small gang of men, women and bullocks required with the *desi* drill. A labour-saving machine for harvesting ground-nuts and a winnowing machine designed to give a clean sample of grain from Indian *bhusa*, are other implements under trial in this Presidency. The manufacture of a furrow-turning plough, a ridging plough and a bullock cultivator designed on the Sepaya farm in BIHAR has been taken up by a local firm. The special characteristics of these implements, apart from their cheapness, are that they permit of the fullest control of the bullocks and are suitable for use in quite small fields. In BURMA, a new

medium sized ploughshare capable of inverting wet paddy soil has been evolved. This new design has found favour among rice-growers, and orders for several hundreds have been received. An improved *guntaka* (blade harrow) of simple design has been invented in MADRAS. It compares favourably with the local implement in weight, draught, cost and length of life, and it can be used both as a harrow and for harvesting ground-nuts and sweet potatoes.

The two types of **power machinery** which have in recent years come into prominence in Indian agriculture are power cane-crushing mills and motor tractors. There are now 52 power crushing plants at work on the Deccan canals. In the United Provinces, where sixteen new installations were erected during the year, it was estimated that not less than 74,000 tons of sugarcane were dealt with by power mills. Though the different types of motor tractors at first imported were not powerful enough except for light and shallow cultivation with disc harrows and cultivators, whole machines and spare parts of the average annual value of Rs. 3,56,000 have been absorbed in the country during the five years ending with 1926-27. Through the pioneer work done at Pusa, the planters in North Bihar have become interested in tractors, and on every estate of any size, there is one in use; some estates have two or three. Now that types strong enough to pull three bottom ploughs in heavy soils have come into the market, the tractor should prove a farm-power unit of considerable possibilities, particularly in breaking up land overrun with obnoxious weeds, of which there are many hundreds of thousands of acres in India. The problem of getting small repairs done without undue delay and of obtaining the services of qualified drivers and mechanics will perhaps be solved in time, as a result of the ever-increasing demand for motor vehicles for road transport in rural areas. The cost of power machinery being far beyond the means of a single landholder, some departments of agriculture are now considering the possibility of using them in the villages either on a co-operative basis or by getting commercial firms to hire them out. In the Central Provinces, *kans*-infested land is being reclaimed by the department at a contract rate of 17 per acre by ploughing it with a steam plough to a depth

of ten inches. During the year under review, 779 acres were rendered fit for cultivation in the Jubbulpore District at a cost of Rs. 13,195 to the owners ; hand-digging would have cost three times the amount. A power threshing machine imported by the United Provinces Department of Agriculture for the use of cultivators gives 70 cwt. of wheat in a working day of 10 hours ; the working cost inclusive of interest and depreciation amounts to only As. 9 per maund of 80 lb.

CHAPTER V.

DISTRICT WORK.

In a country like India, the discovery of improved methods of agriculture is only a very small step towards getting them introduced. It is not sufficient to bring them to the notice of the cultivator; he must be convinced by ocular demonstration, preferably in his own village, that the improvement recommended is likely to give him a substantial financial advantage either in increased outturn or in the reduction of his cultivation expenses. When demonstrating the advantages of improved seeds or implements or of using artificial manures, arrangements must be made to enable the cultivator to obtain them without any difficulty. To this end, the Agricultural Departments have created a vast organization which embraces the activities of thousands of village demonstration plots, seed farms and seed and implement depôts. These are supplemented by agricultural shows, ploughing matches, lectures illustrated by lantern slides and cinema films, and the distribution of popular literature. The two most recent innovations are travelling cinemas and demonstration trains. Reference has already been made to the success attained through these various activities in bringing 10 millions of acres under improved varieties of crops (Appendix I, p. 105). The figures for the sale of implements and fertilizers in Appendices V and VI (pp. 121 & 122) are not so impressive, but, as in the case of areas under improved varieties, they are neither cumulative, nor do they represent the real extent to which these are being taken up by the cultivator. A substantial private trade has sprung up in both in recent years, and though only a part of the demand is being met by Agricultural Departments, sales through them are on the increase. During the year under review, 35,223 improved implements and 24,598 spare parts were sold through departmental agency, as against 29,173 and 19,810, respectively, in the previous year. In the case of fertilizers the increase has been from about 1,000 to 3,600 tons.

In BOMBAY, propaganda and extension work are being directed by six Divisional Boards on which the Agricultural and Co-operative Departments and the non-official public are represented. These Boards work through overseers of the Agricultural Department, agricultural organizers of the Co-operative Department, and Taluq Development Associations subsidized by Government and in some instances by District Boards. The 81 Taluq Development Associations already formed are engaged mainly in extending the use of improved seed and implements, and in organizing shows and campaigns against plant diseases. For the multiplication of pure seed, the department controls large areas in selected parts of the Presidency. In the production and distribution of cotton seed, cotton sale societies play a large part in the Karnatik and Taluq Development Associations in Khandesh. The quantity of seed available from these different sources was sufficient to sow nearly 445,000 acres. In pig-killing campaigns organized by the graduate assistant specially detailed for this duty, 270 pigs were killed.

The 112 demonstrators employed by the MADRAS Agricultural Department carried out during the year 5,430 practical demonstrations on land belonging to cultivators. On these demonstration plots, seeds, implements and cultural methods recommended by the department were contrasted with those commonly used in the villages. They also organized 125 agricultural shows and delivered 241 illustrated lectures. In localities where the demonstration plots have won the confidence of the bulk of cultivators, they are being organized into co-operative demonstration societies for running farms of their own. The total area under private seed farms organized for the production of pure cotton seed now amounts to 7,000 acres; from these and other sources over 500 tons of seed were distributed. The use of green manures for wet land occupies a prominent place in the extension work of the department; 90 tons of sann-hemp, *dhaincha* (*Sesbania aculeata*) and wild indigo seed were distributed. Artificial manures are also coming into increasing favour; the sales through the department rose from 14,415 to 54,286 cwt.—an increase of over 275 per cent. The spraying of garden crops against various diseases and the use of copper sulphate

as a preventive against sorghum smut are other lines of work which have appealed to the cultivators.

In BENGAL, the department is demonstrating its improvements on farms worked by ordinary cultivators who are paid in kind. The first farm of this type started at Kishoregunj five years ago has been instrumental in increasing the area under sugarcane in the sub-division from 400 to 12,000 acres. One hundred and fifty private farms or plots have been established by leading zemindars and Khas Mahal and Court of Wards estates; these are cultivated on the lines recommended by the department. All the jute seed raised on these farms was taken up by cultivators at a remunerative price, and it was not therefore necessary to call on the guarantee against loss given by the Indian Jute Mills Association. The distribution of paddy seed is being carried out in co-operation with the Co-operative Department. The department organized, in the demonstration train run by the East Bengal State Railway, a stall which attracted many visitors.

Over a hundred Kamdars are employed under the supervision of agricultural overseers in carrying out practical demonstrations in cultivators' fields in BIHAR AND ORISSA. As a result of demonstration and propaganda, a satisfactory demand for improved seeds, manures and implements has arisen. The demand is being met to a small extent from the department's farms and by co-operative societies and central co-operative banks. There is, however, a danger of the department's work stopping at the propaganda stage unless the supply of seeds, implements and manures is better organized. Steps are therefore being taken to organize circles of registered seed-growers, whose produce will be purchased at a premium and stored by the department for more general distribution. As regards the sale of manures and implements, it is proposed to place on a more systematic footing the work at present being done by co-operative organizations.

There are 16 seed and demonstration farms and 9 demonstration plots in the UNITED PROVINCES. Owing to a poor season, only 11 of the former and 7 of the latter showed an excess of revenue over expenditure. A feature of the extension work in this pro-

vince is the large number of private farms run on improved lines by persons with capital or land, or both. With an increase of 104 during the year, there are now 859 such farms in the province. Of these, 147 are of 100 acres and more. These farms serve the purpose both of seed depôts and of centres from which improved methods spread to surrounding villages. In districts where enterprise is lacking, the establishment of private farms is being encouraged by offering a subsidy. During the year under review, State aid to the tune of Rs. 59,000 was given to 21 farms, the owners of which had agreed to sell to the department a fixed quantity of seed of guaranteed purity. As in previous years, demonstrations with improved crops, implements and manures were carried out on a large scale on cultivators' fields. From the 161 stores run for the purpose, 7,595 tons of seed, 11,582 implements and 466 tons of manures were sold.

In the PUNJAB, half a dozen large blocks of land have been granted for the establishment of private farms on which the seed of improved varieties evolved by the department are being multiplied. These large and well managed estates also demonstrate in a practical manner that the adoption of improved methods of agriculture results in increased profits. The department runs some hundreds of demonstration plots on land belonging to cultivators; these plots deal with the use of better implements and the sowing of good seed. There are also 118 "better farming" societies organized on co-operative lines, each of which is composed of a number of cultivators who have undertaken to farm their lands in accordance with the advice of the Agricultural Department. For the supply of seed, there is a central depôt in each circle, with sub-depôts at convenient centres. Seed of improved varieties of cotton and wheat sufficient to sow 319,000 acres was sold from these depôts during the year. From similar depôts for the sale of agricultural implements, over 19,000 implements and parts of implements were supplied. Campaigns were organized for the destruction of rats and the swarms of locusts which invaded the province. The departmental cinema lorry toured 1,291 miles and gave 69 shows of films of agricultural interest. The demonstration

train organized in co-operation with other departments visited 70 stations in its tour of three months; at some places the crowds of visitors were so dense that the demonstrators were completely swamped.

With a view to augmenting the supply of pure seed of improved varieties of crops, particularly rice, six new seed farms were opened during the year in BURMA. In addition, 66 areas aggregating about 3,000 acres have been let out to tenants on condition that they will sow only seed obtained from Government farms and sell the produce to the department. The distribution of seed is carried out mainly through co-operative societies and agricultural unions. Over a thousand demonstrations were conducted during the year on small plots placed at the disposal of the department by cultivators or rented for the purpose.

As pointed out by the Royal Commission on Agriculture, the organization for seed distribution is more highly developed in the CENTRAL PROVINCES than in any other province. During the year under review, nearly 9,000 tons of grain seed and a million whole canes were distributed. Of the 6,939 implements sold through departmental agency, 5,780 were ploughs. The district staff carried out 4,339 practical demonstrations, organized 47 agricultural shows and delivered 231 illustrated lectures; the respective figures for the previous year were 3,446, 34 and 54.

Over a thousand practical demonstrations were carried out on cultivators' fields in ASSAM, and seeds, manures and implements of the value of Rs. 76,381 were sold from the three departmental depôts.

Seed of Pusa 4 wheat, Red Assami cane and berseem was distributed in the NORTH-WEST FRONTIER PROVINCE as far as the resources of the Tarnab and Haripur farms would allow. The number of budded plants of improved plums, peaches, apricots and pears sold was nearly 13,000.

Co-operative societies and village panchayets actively co-operating with the MYSORE Agricultural Department in the spread of improved seed, manures and implements now number 129 and 70 respectively. The progress in the introduction of commercial

fertilizers has been particularly striking; about 750 tons were sold almost exclusively for ryots' crops. The estimated total sale of over 13,000 plough shares, exclusive of a very large number made by local blacksmiths, shows that nearly 3,500 improved ploughs absorbed annually in the State are being used. The value of the sales from departmental and other fertilizer depôts in the TRAVANCORE STATE is reported to have increased to nearly Rs. 67,000. The distribution of pure seed of the long-stapled Gaoṛani cotton on the takkavi system formed the principal item of district work in the HYDERABAD STATE. In the BARODA STATE, the department is devoting its attention to the extension of the area under 1027 A. L. F. cotton, Pusa wheats and Karjat selections of Kolamba rice.

CHAPTER VI.

AGRICULTURAL EDUCATION.

It cannot be gainsaid that the educational system of this country has developed along lines which render it unsuited for the major portion of the population, namely, the rural population. Literary education has held the field ever since Lord Macaulay penned his famous minute, and for many years the supply of men trained by the system has been far in excess of the demand. On the other hand, the number of Indians trained up to date in the technique of good agricultural practice is insignificant and quite inadequate. The literary and non-technical system of education which has found favour has, moreover, tended to alienate the sympathies of the sons of the soil from practical farming. It is driving the best of them off the land. A more technical education in secondary schools would have given them a " bias " towards agriculture as a vocation, stimulated their interest in the land and equipped them to be better farmers. The Department of Agriculture in India has within the last 20 years given much attention to the question of giving a practical bent to education in rural areas, and schemes have been formulated by which the teaching of Nature study in primary schools would pave the way for the teaching of the practice and principles of agriculture in middle schools. In this direction the greatest progress has been made in the Punjab, whose beneficent example has been commended by the Royal Commission on Agriculture to other provinces. Local Governments will now, it is hoped, definitely embark on a policy of bringing rural education into touch with the realities of life. The time will come when the demands of an ever-increasing population will make the intensification of production inevitable. That continued scientific investigation is necessary in order to produce this result will only be realized by that nation which includes some knowledge of agriculture and food production in the national education of its citizens. The training of boys in rural areas should in short relate intimately to the life they expect to lead on leaving school.

I. Agricultural Colleges.

The objective of the agricultural colleges in India is to equip students who pass out from them either for posts in Government service or for farming their own land or that of others. No distinction between these two classes of students is, however, made in the courses which are provided, and the colleges are in the main regarded as avenues to employment in the Agricultural Departments. Of the six colleges now working at Poona, Coimbatore, Lyallpur, Nagpur, Cawnpore and Mandalay, the first four are affiliated to Universities. The examination at Cawnpore at the conclusion of the first two years has been recognized by the Intermediate Education Board. The question of affiliating the Mandalay College to the Rangoon University is at present in abeyance, but will be revived as soon as it is found practicable to raise the standard of admission. At the Allahabad Agricultural Institute controlled and financed by the American Presbyterian Mission two courses of intermediate college standard are given—one in agriculture and the other in dairying. Since the closing of the college at Sabour, the three eastern provinces of Bengal, Bihar and Orissa, and Assam are without an institution for higher education in agriculture, for the proposal to start an agricultural institute at Dacca has yet to materialize. The Agricultural Research Institute at Pusa and the Imperial Institute of Animal Husbandry and Dairying at Bangalore provide post-graduate courses qualifying for the highest appointments in the agricultural service.

THE AGRICULTURAL COLLEGE AT POONA, which has entered upon the twentieth year of its independent existence, had 218 students on its rolls, including 79 freshmen. The results of the university examinations were not so satisfactory as in previous years ; 75 candidates sat the examination for the degree of B.Ag. and only 38 passed.

Out of 176 applicants for admission to the AGRICULTURAL COLLEGE AT COIMBATORE, 130 presented themselves for interview by the Selection Committee, on which for the first time non-officials were represented. Forty-one students were selected for admission. At the degree examination held during the year, 20 students appeared and 18 passed.

The 4-year degree course and the leaving certificate course of the AGRICULTURAL COLLEGE AT LYALLPUR attracted over six times as many applicants as could be accommodated. Of the 31 students and ex-students appearing at the final university examination, 16 qualified for the degree. In the examination for the college leaving certificate, 18 passed out of 23.

There were 257 applications for admission to the CAWNPORE AGRICULTURAL COLLEGE, of which 152 were for the diploma course. Five years ago, only 48 students sought admission to the course. In the annual examinations, 10 out of 12 students qualified for the diploma, while 13 out of 17 examined obtained the certificate.

Forty-six students were selected from among 112 applicants for admission to the 4-year degree course of the AGRICULTURAL COLLEGE AT NAGPUR. In the annual examinations, eight of the students admitted previous to the affiliation of the college to the local University obtained the diploma, and five 2-year course students were awarded a certificate in agriculture.

All the nine students in the third-year class of the AGRICULTURAL COLLEGE AT MANDALAY qualified for a diploma. There was a much larger demand for admission to the college than in any previous year. Out of 60 applicants, 20 were selected for stipends and four were granted permission to enter the college as private students.

The two-year post-graduate course at the AGRICULTURAL RESEARCH INSTITUTE, PUSA, was completed, during the year under report, by Messrs. Sailesh Chandra Roy, M.Sc., and Mahbub Alum, M.Sc., in Botany; by Abdus Sattar, B.Sc., in Mycology; by Sher Singh Mangat, M.Sc., in Chemistry; and by M. R. Madhoke, B.Sc., in Bacteriology. Mr. Sailesh Chandra Roy, while under training, was awarded a scholarship by the U. P. Government for study in England, and Mr. Mahbub Alum has since been appointed Assistant Economic Botanist in Bihar and Orissa. Of the 35 candidates for admission to the new session commencing on 1st November, 1927, four were considered by the Selection Committee to be qualified for post-graduate training, but one of them left soon after joining. An Entomological Assistant deputed by the United

Provinces Government for training was admitted to a special course in Systematic Entomology. There were five students under training at this Institute at the close of the year. Ten post-graduate students of the Imperial Institute of Animal Husbandry and Dairying were given short courses at Pusa in estate management, cattle-breeding, plant diseases, etc.

The 15-month post-graduate course in animal husbandry and dairying started at the IMPERIAL INSTITUTE OF ANIMAL HUSBANDRY AND DAIRYING, BANGALORE, on 2nd January, 1927, was completed by five students during the year under report. There were nine applications for admission during the current session; six were selected of whom five actually joined. The third batch of students under training for the Indian Dairy Diploma completed their two-year course in December 1927. Of the 21 candidates appearing at the examination, 18 qualified for the diploma, two with honours. Ten students of the Allahabad Agricultural Institute also presented themselves for the examination, of whom eight were successful. Twenty-seven students were enrolled for the new course which began at Bangalore in November 1927.

II. Agricultural Schools.

The scope and character of the agricultural education which should be given in secondary schools have been subjects of acute controversy in India. Divergencies of opinion have led to the evolution of two entirely different types of school: the vocational school sponsored in Bombay and the 'bias' school in the adoption of which the Punjab led the way. The first type of school purports to fashion a youth of a cultivating or a landholding class into a farmer in two years, while the Punjab type merely aims at giving the boys a 'bias' towards agriculture as a vocation. In the words of a circular issued by the Punjab Government in 1923, "The aim is to enrich the middle-school course in rural areas by the inclusion of agricultural training and thus to bring it more in keeping with the environment of pupils; and the object is to use agriculture as a means of mental discipline and training and as an important accessory to the general subjects taught in these schools." The

special features of the Punjab type are that a small farm or plot is attached to the school and the instruction given in the class room is both illustrated and supplemented by practical work in agricultural processes on the land, by a teacher specially trained for the purpose. The vocational schools have not as yet appealed to the people for whom they are intended. Even in Bombay, which pioneered the experiment, two of the schools opened had to be closed, and the six working at present are not wholly filled with students in search of vocational education. In Madras, the Central Provinces, and Bengal, the results have been even more disappointing. On the other hand, the ' bias ' schools of the Punjab have been so successful that Bombay and the United Provinces have followed their lead by establishing similar schools. The Royal Commission on Agriculture have given it as their opinion that schools of the Punjab type are preferable to those of the Loni type, and have recommended that no more schools of the latter type should be opened and that existing schools in their present form should be closed. It would appear, however, that some provinces are still inclined to experiment, at the expense of the public, with vocational schools of the Loni type.

There were 180 students in the six agricultural middle schools in the BOMBAY PRESIDENCY during the year. These provide a vernacular course of two years in practical agriculture; the attraction of free boarding even has not made these schools popular. They are now being utilized partly for training teachers to be employed in teaching agriculture in ordinary vernacular schools as is done in the Punjab ' bias ' schools. The number of ' bias ' schools in the Presidency is 67, of which eight are in Sind.

Of the two agricultural schools in the MADRAS PRESIDENCY, the one at Anakapalle had to be closed down during the year owing to paucity of students. The other school at Taliparamba attracted 38 students, but eight of them withdrew soon after joining. Altogether sixty boys have taken a full course at this school, but 21 only are reported to be engaged in farming. The classes for juvenile and adult labourers at the agricultural stations at Coimbatore, Palur, and Anakapalle continued to be held during the year.

The one agricultural school remaining in BENGAL, namely, that at Dacca, has not got a full complement of students though the curriculum has been changed. The school is therefore being utilized partly as a centre for giving a refresher course to members of the subordinate agricultural service and partly for training teachers for 'bias' schools. Fifteen teachers have been admitted for training this year; as soon as the hostel is ready it will be possible to take in 15 more.

In BIHAR five middle schools have been selected for the introduction of an agricultural 'bias' course. A Kamdar from the Agricultural Department will assist in running the school garden, and the teachers to be put in charge of class-work will be trained on the Sabour farm.

Out of the 108 students who have taken the two-year vocational course at the Bulandshahr agricultural school in the UNITED PROVINCES, 46 are reported to be engaged on farms belonging to themselves or their families. Among the 64 students on the rolls during the year, 36 were from families owning more than 100 acres of land and 13 from families owning more than 500 acres. The school would appear to cater mainly for the sons of the larger zeminders. Land has been acquired for another school in Gorakhpur, and it is proposed to open classes there in April 1930. Like the Bulandshahr school, the new school will be utilized to some extent for training the teachers required for agricultural 'bias' schools. For the teachers already available, 18 agricultural classes have been established and nine are being organized.

In the PUNJAB, the number of 'bias' schools stands at 121. Each school has either a garden or farm attached to it for practical work; some of the farms are not only self-supporting but show an annual balance to their credit. The aim of these 'bias' schools is to adapt rural education to rural needs; hence the importance attached to practical work, and the desirability of inculcating into the mind of the boys a sense of the dignity of labour.

The conversion of the Powarkhera school in the CENTRAL PROVINCES from a purely vocational school of the Loni type to a prevocational anglo-vernacular middle school of the Punjab type has

proved its salvation. Since the change was made two years ago, the number of students on its rolls has increased from 36 to 69. That the addition of agriculture to the curriculum does not interfere with the other studies is evident from the fact that every one of the 10 boys appearing for the High School Entrance and Scholarship Examination passed, and two obtained competitive scholarships.

Eight students completed, during the year, the full 4-year course of the subsidized agricultural school at Pyinmana in BURMA, which is managed by the American Baptist Mission. This school, like the one at Powarkhera in the CENTRAL PROVINCES, provides a training in agriculture for boys who are given at the same time an ordinary middle English school course. Though not a vocational school, almost half of the boys already trained thereat have returned to the land.

An unusually large number of applications for admission permitted the Hebbal Agricultural School in MYSORE, which provides a 4-year course in English, to admit 27 freshmen as against 18 in the previous year. A good demand for agricultural education in the vernacular as provided in the school at Chikkanhalli has arisen and five more schools of this type are contemplated.

Of the 16 students under training at the Alwaye school in TRAVANCORE, 12 passed the final examination. Another school with 32 students was opened during the year at Kottarakaray and a third one is to be started shortly at Koni.

III. Short Courses.

Short courses in cattle-breeding and dairying were provided at BANGALORE for six students ; in addition to these, 10 Dairy Diploma students from the Allahabad Agricultural Institute received technical instruction at the Bangalore and Karnal farms and the Anand Creamery. At Pusa, one student deputed by the Indian Central Cotton Committee was admitted to a one-year course in Entomology, and two sent by the Bengal Government were given a short course in lac-culture.

The six-month vernacular course originally given during the winter at LYALLPUR having proved its popularity, separate summer and winter classes are now being held at three centres, *viz.*, Lyallpur, Gurdaspur and Hansi. Of the 80 students trained at Lyallpur, 19 were sub-inspectors of the Co-operative Department. At Gurdaspur and Hansi, the students numbered 100 and 40 respectively. The rural economy class, which lasts for a month, was attended by 29 officers of other departments; while 30 senior vernacular teachers qualified themselves for the teaching of agriculture in rural middle schools. With a view to training village blacksmiths to repair oil-engines and modern implements, a two-month course is being given at the agricultural workshop in Lyallpur; 17 of the 20 attending this year's class got a proficiency certificate. Eleven sub-inspectors of the Co-operative Department attended a special one-month course in dairying and veterinary work specially instituted for them. A course in poultry keeping was organized at the poultry farm at Gurdaspur. A one-week course for farmers and a two-week course for practical fruit-growers are the other two innovations of the year.

Eleven teachers, four fieldmen and three engine-drivers passed out of the classes attached to the Bulandshahr agricultural school in the UNITED PROVINCES. Special courses in sugarcane cultivation were organized on the Shahjahanpur farm and a course in practical agriculture on the Nagina farm. At the request of the Chairman of the Agra District Board, systematic practical training was given for a fortnight to selected primary school teachers.

A special sugarcane course organized on the Baramati farm in BOMBAY was attended by 50 cultivators and six officers of the Irrigation Department. Fourteen farmers received training in the handling of simple machinery such as oil-engines, etc., while the horticultural classes attracted 100 adults and school boys.

In BURMA, short courses were given to 68 adult farmers at the principal central farms. All the 10 students who took a practical course of nine months at Mahlaing have returned to the land.

Attempts to induce sons of cultivators to come to Government farms in BENGAL for practical instruction in modern agriculture

did not meet with any appreciable success, but similar facilities provided at sericultural nurseries in this province were taken advantage of by 195 boys. In BIHAR AND ORISSA, a nominee of a co-operative bank was trained as a Kamdar on the Cuttack farm. In Assam the apprentice demonstrators under training on the various farms numbered 14 at the close of the year under report.

On the BARODA farm the short practical course given was taken advantage of by 18 youths.

CHAPTER VII.

THE CO-OPERATIVE MOVEMENT AS AFFECTING AGRICULTURE.

The co-operative movement is in a somewhat unhealthy condition in at least three provinces. Outside the Punjab and Bombay, it has not yet touched even 10 per cent. of the families in rural areas. The fact remains nevertheless that a system of rural credit has been established, which, if carefully fostered, should, in course of time, relieve the cultivator of that burden of usury which he has borne so patiently throughout the ages. In 1927-28, there were in British India some 72,000 agricultural credit societies with nearly two and a half million members and a working capital exceeding 26 crores of rupees. So far little progress has been made with forms of co-operative activity connected with purchase, production and distribution, but it is significant that most of the 2,600 societies engaged in other branches of business besides the borrowing and lending of money are in the four provinces where the credit system is best developed (Appendix IX, p. 128).

Bombay. The number of agricultural credit societies rose from 4,022 to 4,177, the membership from 260,182 to 263,493 and the working capital from Rs. 346 lakhs to Rs. 353 lakhs. With the weeding out of seven dormant societies, the number of non-credit agricultural societies has been reduced to 257. As many of these are not working properly, the Provincial Registrar anticipates that the number may have to be reduced still further. Societies for the sale of agricultural produce of agriculturists, more particularly cotton, continued to do well; but the small seed and implements societies are not thriving and their business is being reduced year by year. Twelve cattle-breeding societies are left on the register; of these three only are doing useful work. Among the land improvement societies, the Yelvigi and Maharajpeth societies deserve mention; they brought during the year 175 acres of land under cultivation.

Madras. The number of agricultural credit societies rose from 11,000 to 11,966, the membership from 583,315 to 630,298, and the working capital from Rs. 489 lakhs to Rs. 574 lakhs. With an increase of 8 during the year, the number of land mortgage banks stood at 18; proposals to federate them into a Central Bank at Madras are under consideration. The number of societies devoted to purchase and sale increased from 116 to 127; with a smaller working capital, they expanded their trading activities from Rs. 5,01,000 to Rs. 6,88,000. Among the ten new societies for production and sale, one has as its object business in poultry and eggs. The 348 societies representing other forms of agricultural co-operation include 15 for agricultural demonstration, 9 for land reclamation and 17 for irrigation.

Bengal. The number of agricultural credit societies rose from 13,398 to 15,689, the membership from 329,765 to 382,152, and the working capital from Rs. 321 lakhs to Rs. 378 lakhs. Satisfactory progress has been made, too, in the development of other forms of co-operation. Societies for purchase and sale now number 85 as against 22 four years ago, while irrigation societies have increased from 173 to 525 in the same period. Societies for the sale of jute have been strengthened by being federated into a central society at Calcutta, and have in consequence extended their business to a great extent. A similar central organization for co-ordinating and guiding the activities of the paddy sale societies was created during the year. Of the irrigation societies, 267 are in Birbhum and 204 in Bankura. Of the 31 co-operative agricultural associations organized to run seed farms on commercial principles, those at Naogaon and Chaudanga continued to play a useful part in supplying their members with improved seed and agricultural implements.

Bihar and Orissa. The number of agricultural societies rose from 7,614 to 7,934, the membership from 205,825 to 220,889, and the working capital from Rs. 200 lakhs to Rs. 206 lakhs. In the non-credit group, only four societies for purchase and sale and 10 for production and sale are left and they are not working well. The 87 grain *golas* (stores) at work during the year earned a profit

of Rs. 21,849 on a working capital of Rs. 3,10,140. The best managed *golas* are those in the Santal Parganas; many of those in other parts of the province are in a moribund condition and will have to be closed down.

United Provinces. The present policy of the department is to concentrate on the improvement of existing societies and to close those which have failed badly. The number of agricultural credit societies has been reduced by 177 to 5,697, and their membership by 10,878 to 137,454. The working capital of Rs. 97,57,000, however, showed an increase of Rs. 4,78,100. The number of non-credit agricultural societies rose from 6 to 16; among the latter are six rural reconstruction societies in the Benares District, and six and two societies devoted, respectively, to the consolidation of holdings and the introduction of better farming.

Punjab. The number of agricultural societies increased from 14,148 to 15,299, the membership from 402,585 to 453,133, and the working capital from Rs. 536 lakhs to Rs. 634 lakhs. The eleven mortgage banks at work during the year advanced 152 loans for the redemption of land and nine for the improvement of land. One hundred and twenty-two new societies for the consolidation of holdings were registered during the year, as against 81 in 1926-27. The area covered was 64,699 acres, in which 55,655 blocks were, by redistribution, reduced to 8,883; the average size of the block was increased from 1·16 to 7·3 acres. Since this important form of co-operative activity was started in 1921, 163,000 acres have been consolidated; the number of new wells sunk and old wells repaired in this area is estimated to be 581. The societies for silt clearance number 26; they continue to do valuable work. The 174 societies for cattle-breeding are described by the Provincial Registrar as little more than associations of cultivators who feel the need for better cattle but are at present powerless to breed them. Over 10 per cent. of their 4,500 members have no cows, and about 100 societies are doing nothing *qua* societies. Only one of the three sheep-breeding societies is expected to survive. Of the 21 milk-recording societies, seven in Montgomery, where the members are bound by the cattle-breeding conditions of their grants, are operat-

ing regularly. The number of better farming societies increased from 99 to 118 : they sold 222 tons of improved wheat and cotton seed to their members and a considerable variety of implements including 407 ploughs, 75 fodder cutters, 50 harrows and 35 drills. The five land-holding societies are not doing well, but the four societies for reclamation of waste land in Hoshiarpur reclaimed 227 acres. With an increase of one during the year, the commission shops now number 19 ; they sold produce worth Rs. 35 lakhs. Of some 200 bodies for rural supply started during the war and post-war period, only 5 unions and 14 societies are surviving ; most of them are doing well. The 15 land revenue redemption societies, the object of which is to build up a fund by annual contributions sufficient after 12 years to produce enough interest to pay a member's land revenue indefinitely, are still in the experimental stage. Other interesting examples of agricultural thrift are the crop failure relief and provident societies and societies for the storage of fodder.

Central Provinces. The elimination of unsatisfactory societies is being carried out with vigour ; the number of agricultural credit societies declined in consequence from 3,966 to 3,891. The membership of 61,559 and the working capital of Rs. 162 lakhs, however, showed an increase of 3,520 and over 3 lakhs of rupees, respectively. The number of credit societies doing seed business in the Sihora tehsil increased from 57 to 85, but their management leaves much to be desired. Of the four surviving agricultural unions organized for the production and distribution of cotton seed, one is doing no work, while three did business of the value of Rs. 979 only. Agricultural associations for the sale and hire of implements are on the other hand slowly gathering strength.

Burma. At the close of the year, there were on paper 3,901 agricultural credit societies with a membership of 85,785 and a working capital of Rs. 236 lakhs. The number of living societies, however, did not exceed 3,300 and " many of these were barely alive." With the limited staff of the department buried in liquidation work of some 1,300 hopelessly bad societies, the registration of new societies is at a standstill. The enthusiasm of the Honorary

Organizers " has steadily ebbed with the passing of the era when ten signatures to an application for registration brought a prompt supply of hard cash and the Hony. Organizer, the giver of the feast, had flowers strewn in his way in every village." Almost all the 67 non-credit agricultural societies are in such a condition that their liquidition is only a question of time.

Assam. The number of agricultural credit societies rose from 998 to 1,120, the membership from 42,478 to 48,197 and the working capital from Rs. 18,31,145 to Rs. 22,47,285. The land mortgage banks at Kamrup and Sylhet made good progress during the year; a third one has since been started at Sibsagar. The only non-credit agricultural society in the province deals in jute; it is already encountering difficulty in disposing of its produce at a profit.

Delhi. With a net increase of 29 during the year, there are now 233 agricultural credit societies in this small province; the membership similarly rose from 4,250 to 4,672, and the working capital from Rs. 5,82,764 to Rs. 6,22,272. Among the new developments of the year may be mentioned the organization of a cattle-breeding society and a better farming society.

Co-operative Cotton Sale Societies.

There are 31 cotton sale societies in the Bombay Presidency, of which eight are in the Southern Division, two in Khandesh and 21 in Gujarat. They sold during the year under report cotton of the value of Rs. 35 lakhs, distributed a large quantity of improved cotton seed, and earned a profit of Rs. 23,000. In Khandesh, the Pachora society continued to do good business; all attempts to revive the other at Nandra have failed. The 15 working societies in Gujarat, which are distinguished from those in the Karnatak in that they sell only members' cotton, sold cotton lint and seed worth Rs. 10 lakhs. In the efficiency of their organization and management, societies in the Surat District stand first; they have acquired a status in the market which enables them to deal directly with the mill owners and agents.

Co-operative Milk Societies.

The number of milk societies in BENGAL increased from 97 to 123; 93 of these are affiliated to the Co-operative Milk Union in Calcutta. The latter realized Rs. 5,64,261 by the sale of milk, reduced its outside liabilities by Rs. 44,376, and earned a net profit of Rs. 23,545. The success of this Union has led to the creation of similar central organizations at Dacca and Darjeeling. Of the seven societies in the BOMBAY PRESIDENCY, three, including the one newly started at Surat, worked at a profit. Milk societies organized in the Chingleput District for the supply of milk to the town of MADRAS now number 20. The *goali* society at Telinkheri in the CENTRAL PROVINCES, which supplies fresh milk to the Nagpur city, continued to work well, but the Amraoti dairy is in a hopeless financial position. Of the three dairy societies in the UNITED PROVINCES, the one at Lucknow has been cancelled, and that at Benares is awaiting the same fate; the third which is at Allahabad has been hit by an embezzlement. The dairy society at Mayaganj in BIHAR AND ORISSA is running at a profit.

Cattle Insurance.

Cattle insurance societies have proved a failure wherever they have been tried in India. Only one of the seven societies registered in BOMBAY was able to collect premia: the four societies registered two years ago in Madras have not as yet done any business worth the name. In BURMA, there are still 389 societies on the books of the department but 350 of them have not worked for 5 years.

CHAPTER VIII.

LIVE STOCK.

1. Prevention and Treatment of Disease.

With the abatement of the ravages of rinderpest in the eastern provinces, the total reported mortality from contagious diseases dropped from 322,331 to 311,222 for the year under review. Rinderpest alone accounted for almost 60 per cent. of the deaths. The provinces which suffered most were Burma, Madras and the United Provinces, each of which lost through rinderpest over 30,000 bovines, while the Punjab recorded more than 20,000 deaths from this fell disease. The number of preventive inoculations performed rose from 1,527,213 to 1,727,055. The gradual rise in the number of cattle voluntarily offered for protection indicates that the value of western prophylactic methods is appreciated by cattle-owners in this country. The mortality from rinderpest in the United Provinces would, we are told, have been appreciably less " if the supply of serum had not been suspended temporarily for want of funds." The Director of the Veterinary Department in the neighbouring province of the Punjab also states that the demand for serum inoculation was so great that his department had difficulty in meeting the cost of the serum required. In Madras and Bihar and Orissa, the position was equally unsatisfactory, as may be gathered from the fact that 723 and 1,710 reported outbreaks respectively remained unattended for want of adequate staff.

The number of hospitals and dispensaries maintained for the treatment of disease rose from 786 to 831, and the cases treated therein from 1,904,478 to 2,106,107. In addition, 1,320,729 cases were treated by itinerant veterinary officers, as against 1,226,256 in the previous year. The total number of cases treated was 3,426,836, as compared with 3,130,734 in 1926-27 (Appendix X, p. 132).

In addition to the measures adopted for saving cattle from the ravages of disease, the Veterinary Department performs the important function of emasculating inferior and undesirable bulls. During the year under review, 408,396 scrub bulls were castrated in British India, of which 272,185 were in the Punjab. The introduction of the Burdizzo castrator, by which an animal can be rendered sterile without cutting the skin or shedding blood, has rendered the operation unobjectionable to the religious susceptibilities of the people, and it is to be hoped that this will, in course of time, result in an appreciable increase in the number of animals offered for castration, particularly in provinces where old prejudices seem to be dieing hard.

II. Incidence of Disease.

Bombay. With a further decrease in the incidence of rinderpest, the mortality from contagious diseases dropped from 11,613 to 8,031. Foot-and-mouth disease was also less prevalent, but hæmorrhagic septicæmia and blackquarter were more rife than usual.

Madras. The year was noteworthy for a regretable increase in the mortality from contagious diseases, the number of deaths reported being 76,289 which is the highest recorded since 1909-10. Rinderpest was the main contributory cause towards the increase, and accounted for 35,803 deaths.

Bengal. Outbreaks of contagious diseases were of less frequent occurrence than usual, and the mortality dropped, in consequence from 35,719 to 16,066. The most striking decrease was under the head rinderpest which accounted for only 11,790 deaths, as against 33,405 in the previous year.

Bihar and Orissa. Both rinderpest and hæmorrhagic septicæmia were more prevalent than in 1926-27, with the result that the total mortality from contagious diseases rose from 9,318 to 14,761.

United Provinces. The total mortality of 41,192 showed an increase of 10,403 over the figure for the previous year.

Punjab. There was no substantial reduction in the mortality from rinderpest; the total number of deaths from contagious diseases of all kinds was practically the same as in 1926-27. Surra was less prevalent among bovines; only 295 animals succumbed to it as against 1,380 last year.

Burma. Rinderpest accounted for 90 per cent. of the 41,955 deaths from different bovine diseases. The mortality from anthrax was less than in the previous year, but foot-and-mouth disease was more widespread.

Central Provinces. Though rinderpest took a heavier toll than last year of the cattle of this province, the total mortality from contagious diseases was about the same as last year. Blackquarter was less rife.

Assam. The mortality from rinderpest dropped by over 56 per cent.; the number of deaths from contagious diseases of all kinds was only 31,105, as against 52,956 last year.

North-West Frontier Province. With an increase in the incidence of rinderpest, the total mortality from contagious diseases rose from 3,636 to 4,557.

Sind. Of the total reported mortality of 4,682, rinderpest is supposed to have been responsible for 2,911 deaths.

Baluchistan. The total number of deaths reported was 8,798, as against 4,996 in the previous year. The increase was due to the wider prevalence of anthrax and of goat and sheep scab.

Rajputana. Of the 87 recorded deaths, 59 were from surra. No case of bovine disease was reported.

III. Preventive Inoculation.

A natural periodic decline in the prevalence and intensity of outbreaks of rinderpest in some parts of India reduced the demand for the products of the Imperial Institute of Veterinary Research at Muktesar from 6,318,758 doses in 1926-27 to 6,133,509 for the year under report. The decrease in the demand for anti-rinderpest serum was, to some extent, counterbalanced by the larger use of the prophylactics manufactured for dealing with other bovine diseases, such as hæmorrhagic septicæmia and blackquarter.

The following table compares the number of doses issued during the year under review with the average numbers for the previous five years :—

	1927-28.	Average of previous 5 years.
Rinderpest serum	48,60,758	27,55,576
Anthrax serum	48,155	32,529
Hæmorrhagic septicæmia—		
Serum	4,67,072	1,86,328
Vaccine	4,48,153	1,63,025
Blackquarter aggression . . .	1,33,401	35,593
Mallein	90,129	71,182

After meeting this heavy demand, over 37 lakhs of doses remained in stock at the close of the year. This satisfactory position has been attained mainly by developing the resources of the sub-station at Izatnagar where the whole of the required anti-rinderpest and anti-hæmorrhagic septicæmia sera is now manufactured.

Of the 4,860,758 doses of anti-rinderpest serum issued, 4,470,461 doses were used in what is known as the serum-alone or passive method of preventive inoculation. This method has been accepted as the most suitable for India on account of its simplicity and absolute safety. It is, however, subject to the very serious limitation that it confers complete immunity for less than a fortnight, whilst infection may persist in a village for a much longer period. A more lasting immunity is no doubt conferred by allowing inoculated animals to mix immediately with infected ones and to contract a mild infection, but the chances that the disease will be contracted at the right moment are not good. To ensure infection, therefore, another process known as the serum-simultaneous or active method of conferring immunity has been devised. In this process, a small quantity of blood containing the virus of rinderpest is injected into the animal at the time that the anti-rinderpest serum is used. A mild attack of rinderpest follows, the tissues of the animal prepare their own anti-bodies and an immunity, which is believed to be permanent, is set up. Though a certain amount of risk is associated with this active method of immu-

nization, the results obtained in Mysore State in recent years and in the Madras Presidency in the early part of 1928 indicate that it could, with advantage, be used on a larger scale in India. In Madras, the percentage of mortality among animals inoculated by the serum-alone method was 0·39 as against 0·14 per cent. for animals inoculated by the serum-simultaneous method.

The second most important cattle disease in India is hæmorrhagic septicæmia. In affected districts, notably in the Punjab, liable to seasonal visitations cattle are treated preventively on a large scale by vaccination. Of the 291,117 thus protected in the Punjab during the year, only two were reported to have died.

The " pillule " form of vaccine previously issued for combating blackquarter has now been entirely supplanted by the more effective " aggressin." It is reported from the Central Provinces that in certain villages where blackquarter had occurred from time to time animals protected with " aggressin " escaped infection.

IV. Veterinary Education.

For the training of students in veterinary science, there are colleges at Bombay, Madras, Calcutta and Lahore and schools at Insein and Taunggyi in Burma. A veterinary college is being constructed at Patna for Bihar and Orissa ; it will begin to admit students in July 1929. This college will have a cattle-breeding and dairy farm attached to it, on which students will be given practical instruction in animal husbandry and dairying. The colleges at Bombay, Madras and Calcutta give a 3-year diploma course in English, while that at Lahore provides a 4-year course. With a view to turning out a better type of veterinarian, the standard of admission to the latter course has been raised from Matriculation to the First Examination in Arts or Science, but for the next two years first class Matriculates will also be admitted. The colleges at Madras and Lahore provide post-diploma classes for selected subordinate officers of the department. The number of students who passed the diploma examinations of the colleges was 75 as against 59 in the previous year and 50 in 1925-26 (Appendix XI, p. 133).

The veterinary school at Insein has not yet been raised to the status of a college. The offer of 20 stipends of Rs. 25 each attracted only one candidate who had studied up to the High School Final. The Taunggyi School has remained closed since July 1927.

At the Imperial Institute of Veterinary Research, Muktesar, three officers of the Army Veterinary Corps and one officer and six subordinates of the Civil Veterinary Department in British India and Indian States received short courses in laboratory methods. Eight veterinary subordinates of the Military Department received practical training in new methods of surra treatment. The two officers of the Mysore Veterinary Department deputed to Muktesar for a three years' special course completed their studies and returned to their State during the year under review. Four farriers were trained at Lahore and one farrier and two dressers at Calcutta. At the latter institution two courses of lectures and demonstrations on infectious diseases of animals were given to students undergoing training as sanitary inspectors. Seven students passed out during the year from the veterinary compounders' class attached to the Nagpur hospital.

V. Veterinary Research.

As the superior officers on the cadres of the Provincial Civil Veterinary Departments are fully occupied with administrative and teaching duties, veterinary research has hitherto been practically confined to the Imperial Institute of Veterinary Research at Muktesar. A welcome departure in the direction of fostering investigation in the provinces has, however, now been made by the appointment of special veterinary research officers in the Punjab and Burma.

Rinderpest. Extensive experiments are in progress at Muktesar to elucidate the nature of the rinderpest virus. The successful propagation of the virus in goats has provided the means of obtaining clean virus, *i.e.*, virus free from contaminating piroplasms, for use in the field for serum-simultaneous immunization. In Northern India, 1,119 cattle were inoculated during the year by the serum-simultaneous method involving the use of locally "manu-

factured " goat virus ; the mortality among the inoculated cattle was reported to be nil.

Experiments were carried out with a view to ascertaining whether goats can be used instead of hill bulls for the testing of anti-rinderpest sera : they were found to be much less satisfactory than bulls.

Surra. The curative treatment of equine surra evolved at Muktesar was tried in a formidable natural outbreak at the Army Remount Depôt at Mona. Of the 56 animals subjected to five injections of " Bayer 205 " at fortnightly intervals, four succumbed to conditions other than surra, three suffered relapses of surra, and 49 or 94·2 per cent. were definitely cured. Satisfactory results were also obtained when the same non-metallic organic compound was administered to the fox hounds of the Delhi Hunt when suffering from the canine species of surra.

Piroplasmosis. Experimental observations at Muktesar have resulted in information pointing to the efficacy of curative treatment by repeated injections of tryparsamide in some outbreaks of canine piroplasmosis set up by *P. gibsoni.* In Madras, the use of Noversenobillon has been found effective.

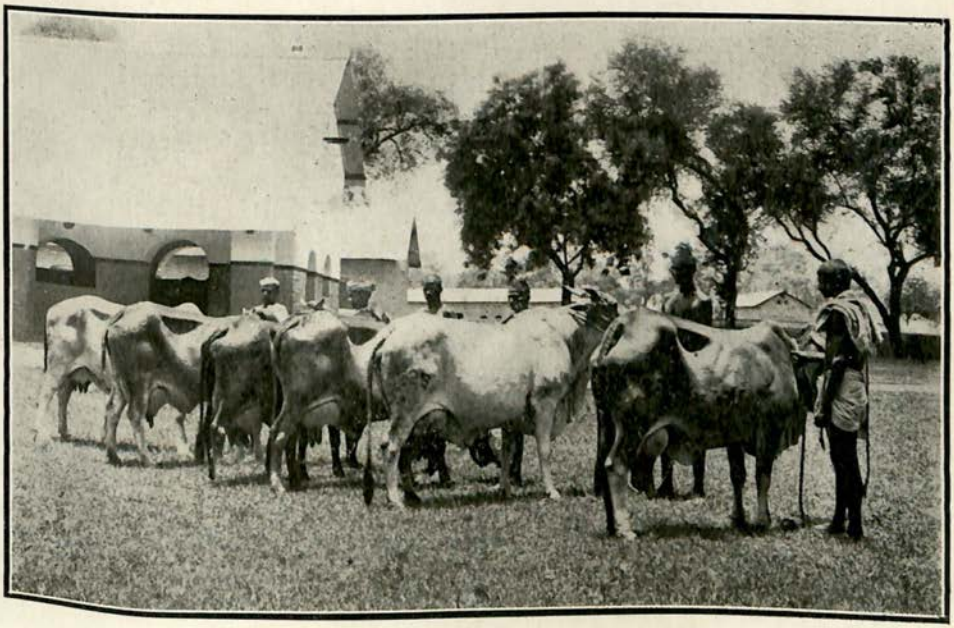
VI. Breeding.

Cattle-breeding. The repeal of the Corn Laws obliged the British agriculturist to take as his motto, " Cattle first, corn second," or " Up horn, down corn," as this policy was popularly described at the time. In India, too, the tendency for many years has been to give precedence to the cultivation of money crops. The Royal Commission on Agriculture have pointed out that British India has 61 cattle and buffaloes per 100 human population and 67 for every 100 acres of cultivated area. We have thus twice as many cattle per 100 of population as other thickly populated countries such as Great Britain, Germany and Japan, and almost three times as many per 100 of population as Egypt where the general conditions under which agriculture is carried on are almost similar to those which obtain in India. Even with such obvious overstocking, the draught power available for tillage operations is

inadequate, and there is a general shortage of milk and milk products. Such a position the Royal Commission on Agriculture in India ascribe to what they call a vicious circle. They proceed to describe it in the following words :—

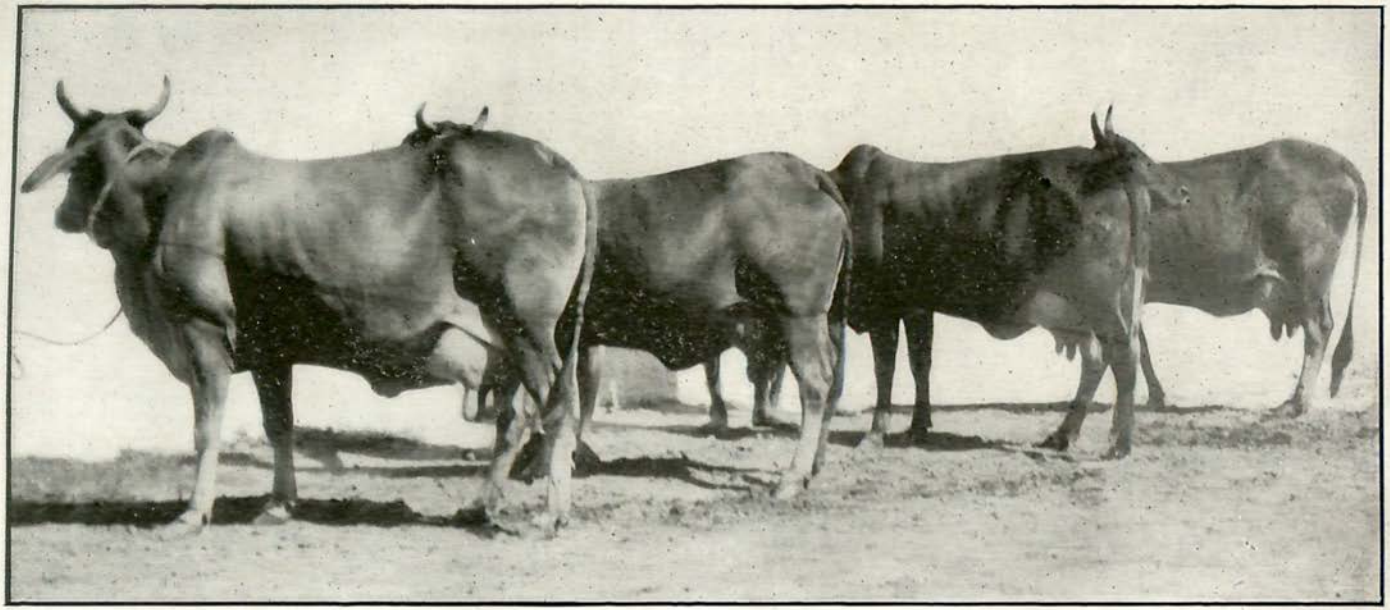
" The number of cattle within a district depends upon, and is regulated by the demand for bullocks. The worse the conditions for rearing efficient cattle, the greater the numbers kept tend to be. Cows become less fertile and their calves become undersized and do not satisfy cultivators who, in the attempt to secure useful bullocks, breed more and more cattle. As numbers increase, or as the increase of tillage encroaches on the better grazing land, the pressure on the available supply of food leads to still further poorness in the cows. As cattle grow smaller in size and greater in number, the rate at which conditions become worse for the breeding of good live stock is accelerated. For it must not be supposed that the food required by a hundred small cattle is the same as that needed by fifty of double the size. As cattle become smaller, the amount of food needed in proportion to their size increases. Thus large numbers of diminutive cattle are a serious drain on a country in which the fodder supply is so scarce at certain seasons of the year as it is in India. The process having gone so far, India having acquired so large a cattle population and the size of the animals in many tracts having fallen so low, the task of reversing the process of deterioration and of improving the live stock of this country is now a gigantic one ; but on improvement in its cattle depends to a degree that is little understood the prosperity of its agriculture and the task must be faced."

Though the problem is admittedly a formidable one, it is believed that improvement can be effected by selective breeding, cross-breeding and better feeding. The different breeds are therefore being studied, and pure bred herds established with a view to providing a foundation whereon the edifice of improved cattle-breeding and dairying can, in course of time, be raised. Given this foundation, it is possible to raise breeds of cattle which will give good draught bullocks and profitable milch cows. Much attention is also being paid to the question both of growing and



A GROUP OF SAHIWAL COWS AT PUSA.

PLATE VII.



SOME OF THE HIGH YIELDING COWS OF THE SCINDI BREED AT THE IMPERIAL INSTITUTE OF ANIMAL HUSBANDRY AND DAIRYING, BANGALORE.

storing fodders. Luscious fodder crops unknown in India previously have been introduced; methods of storing fodders in silos and in the dry state have been devised, and accurate information regarding the digestibility and nutritive values of different foodstuffs and fodders is being collected. With the object of demonstrating the possibilities of transporting milk from rural areas where it is relatively cheap to urban centres where it is dear, schemes have been promoted for supplying milk to the towns of Calcutta, Nagpur, Muzaffarpore, Agra, Hathras, Nainital, Jhansi, and Lucknow. Persons capable of taking charge of such schemes are being trained at the Imperial Institute of Animal Husbandry and Dairying at Bangalore, and expert advice in technical matters connected with cattle-breeding and dairying has been made available to Provincial Departments of Agriculture, city municipal corporations and private individuals.

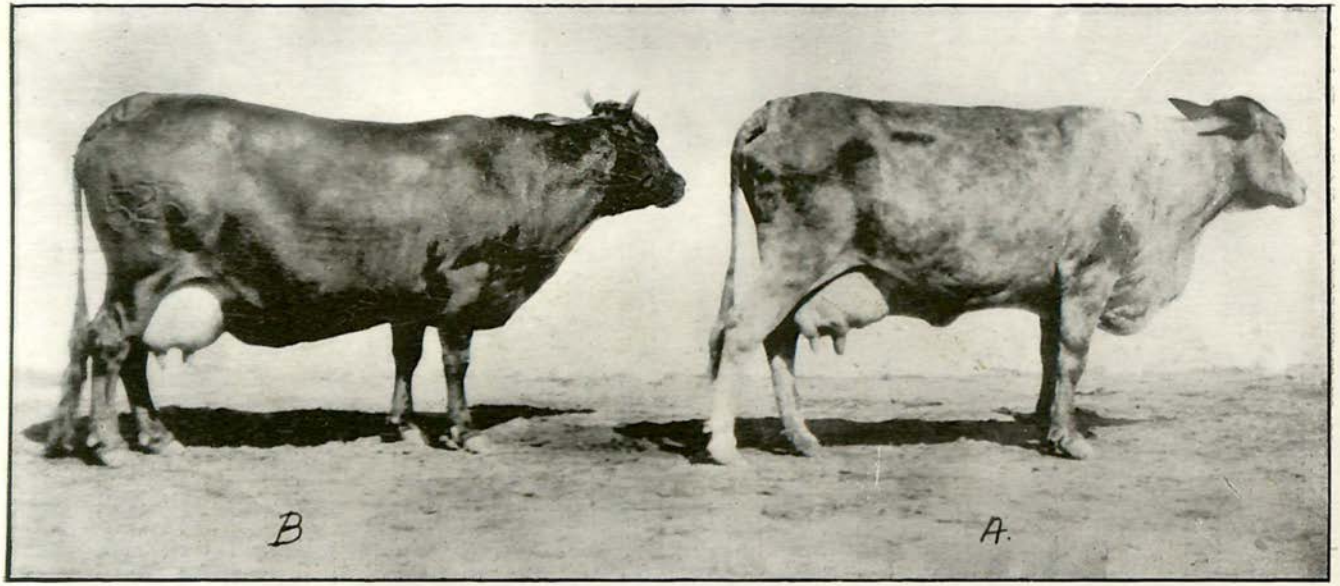
With a view to stimulating and to some extent co-ordinating the efforts being made in the various provinces and Indian States towards cattle improvement, the Government of India have established at Bangalore a Central Bureau for Animal Husbandry and Dairying with the Imperial Dairy Expert as Secretary. The first task to which the Bureau has applied itself is that of encouraging the formation of herds of pure bred cattle by private owners.

As stated in previous reviews, cattle-breeding operations at PUSA are being directed along two lines. A herd of Sahiwals or Montgomeries is being graded up by selective breeding, and the poorer milkers of the same breed are being crossed with Ayrshire bulls of high milking pedigree with the primary object of obtaining reliable information regarding the inheritance of observable characters in the crosses. In the pure Sahiwal herd, six cows gave during the year under report over 4,800 lb. of milk each in a lactation period of 304 days; among the half-bred progeny of rejected Sahiwal cows sired by Ayrshire or Holstein bulls, the yields of eight cows were over 7,600 lb. In the Montgomery herd the average yield per cow per day was 12·7 lb., while in the cross-bred herd it was 21·6 lb. The average percentage of cows in milk was 51 for the Montgomery herd and 68 for the cross-bred herd. The cross-breds

thus give much more milk than the pure-bred Montgomery herd and a greater number of calves over a period of years. It must, however, be remembered that half-bred animals are less hardy and disease-resistant than those of pure indigenous breeds, and that these disadvantages tend to become more accentuated by the further introduction of foreign blood. Having produced a cross of good milking capacity by cross-breeding, attempts are now being made to adapt the cross to local conditions by mating half-bred dams with Sahiwal bulls of good milch pedigree. The ¼-Ayrshires thus produced are promising: one of them gave during the year under review over 4,800 lb. of milk in a lactation period of 304 days.

In accordance with the breeding policy adopted at Pusa, most of the cross-bred cows on the BANGALORE and WELLINGTON farms are now sired by Indian bulls of good milch pedigree. At KARNAL, herds of Thar-Parkar and Hariana cattle and of Murra buffaloes, and at Wellington and Bangalore herds of Scindi cows are being built up. Six cows each of the Hariana and Thar-Parkar breeds gave yields of over 3,500 lb. of milk at Karnal during the year under review. The creamery at ANAND is being run as a butter factory. It is being utilized, too, for experimental work in connection with the transport of fresh milk to Bombay and the manufacture of *ghee*, condensed milk and casein.

The PUNJAB is the home of excellent Indian breeds of cattle such as the Hariana, the Dhanni and the Sahiwal or Montgomery. The policy of the Veterinary Department, which is in charge of stock-breeding operations, is to improve these breeds by selection. The Hariana herd on the Hissar farm is the only one to which this method of improvement has been thoroughly applied up to date. The bulk of the 2,890 bulls at stud in the province were bred and raised on this farm; but a limited number of Hariana bulls is also being supplied from three private breeding farms started on land granted by Government for the purpose of cattle-breeding. Bulls of the Sahiwal and Dhanni breeds are obtained for distribution by subsidizing breeding operations on similar lines. From these different sources 732 bulls were obtained during the year for stud purposes, of which 439 came from the Hissar farm. Steps are



CROSS-BRED COWS BORN AND BRED AT THE IMPERIAL INSTITUTE OF ANIMAL HUSBANDRY AND DAIRYING, BANGALORE.
A—Cow No. 133 " Jill "—age 20 years—has given 17 calves and 151,786 lb. milk to date with a record yield of over 12,000 lb. in one lactation period.
B—Cow No. 523—age 12 years—has given 9 calves and 81,346 lb. milk to date, of which over 13,000 lb. were given in one lactation period.

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PLATE IX.



Ayrshire calves born and bred at the Imperial Institute of Animal Husbandry and Dairying, Wellington.



Cross-bred Ayrshire and Scindi young stock born and bred at the Imperial Institute of Animal Husbandry and Dairying, Wellington.

being taken to increase the number by strengthening the breeding herd at Hissar and by starting additional Government farms in the Nili Bar Colony and in North Punjab. The three District Boards in the Hariana tract received grants of Rs. 30,000 conditional on their spending a like amount, while five in the Dhanni tract were given Rs. 28,000 on similar terms. In the Gurgaon District alone there are now 617 approved bulls, of which 150 were purchased during the year from the Hissar farm. The latter number was distributed among cattle-owners who paid one-quarter of the purchase price. In the NORTH-WEST FRONTIER PROVINCE, 35 bulls belonging to local bodies were at stud during the year. The small herd of Awankari cattle started at the Tarnab farm in 1916 is flourishing, and an increasing number of village cows is brought to the station for service.

In the UNITED PROVINCES, there are two cattle-breeding farms, one at Madhurikund in the Muttra District and the other at Manjha in Kheri Lakhimpur. Land has been acquired for a third farm at Jhansi, where the formation of pedigree herds of the more important types of Bundelkhand cattle will be taken up next year. The recent extension of the Madhurikund farm has permitted the aggregate strength of the various herds to be raised to 1,230. On this farm there are herds of Hariana cattle and Murra buffaloes. On the farm at Manjha pure herds of the local Kherigarh and Sahiwal cattle and Murra buffaloes are maintained. The last two types have been imported with a view to improving the milking capacity of the local cattle: the Montgomeries in particular are standing Terai conditions very well. There is a good demand for the bulls reared on the Government farms; 635 were distributed in the year under review as against 262 in 1926-27. There are now 1,222 selected bulls at stud in the province, as compared with 239 in 1922-23 when cattle-breeding work was transferred to the Agricultural Department. In the two controlled breeding areas started in the districts of Muttra and Etawah, there are 250 approved bulls.

A scheme for the extension of cattle-breeding operations in the CENTRAL PROVINCES has been prepared. It provides for the establishment of pure bred herds at five centres, the conversion of

seven existing cattle farms into depôts for young stock, and the opening out of forest areas for grade breeding. In fulfilment of this scheme, two large blocks of forest land have been taken over at Bod in the Melghat and at Pendra in Chhattisgarh. The old military area acquired at Ellichpur is to be utilized for breeding pure bred bulls of the Hariana breed for Berar. The 19 young bulls of the Gaolao breed available for sale at the Garhi farm fetched an average price of Rs. 294 per head.

The mating of BENGAL cows at the Rangpur farm with Hansi bulls has produced a desirable cross which is suitable for the province. The milk yield has been much improved, and the size of the bulls produced on the farm has been increased. All premium bulls issued under a scheme sanctioned during the year will be concentrated in the Malda District. In BIHAR and ORISSA, the Agricultural Department has cattle-breeding herds at Kanke and Monghyr, a Murra buffalo-breeding herd at Sepaya and the nucleus of a herd of Orissa cattle at Cuttack. The milk yield per cow has risen to nearly 14 lb. per day on the Kanke farm. The net yield of milk (*i.e.*, the quantity left after the calf has had its share) has risen at Cuttack from 1 or 2 lb. per cow to 6 lb. The number of bulls issued from these three cattle farms during 1927-28 was 36. On the Patna cattle-breeding and dairy farm which is under the control of the Veterinary Department, cows of the local breed are being mated with Thar-Parkar bulls. In addition to the original stock of Patna cattle, a herd of Sahiwals (Montgomeries) has been established on the Upper Shillong farm in ASSAM. It is proposed to use an Ayrshire bull for both these herds. The newly established farm at Khanpara will have two distinct herds, *viz.*, one of pure Scindis and the other of the progeny of Bihari cows crossed with Thar-Parkar bulls. On the Jorhat farm, Thar-Parkar bulls are being used in grading up the local cattle. As a Live Stock Expert has recently been appointed, cattle-breeding operations in Assam will, in future, be conducted under his guidance. A beginning in stock-breeding has been made at Tatkon in BURMA. The small herd of Scindi cattle established at the Mandalay college for instructional purposes is doing well.

The breeds under improvement in BOMBAY are the Kankrej at Chharodi and Surat, the Amrit Mahal at Bankapur, the Scindi and Thar-Parkar at Karachi and the Tapti-Khillari at Sangvi. The department is subsidizing two *gowshalas* at Kandivli and Mulund for the improvement of Gir cattle. The number of bulls issued during the year was 53. Four cattle-breeding farms are being maintained in MADRAS, the largest being at Hosur where there are herds of selected Ongole, Kangayam and Scindi cattle. On this farm there is also a mixed herd of cross-bred cows; their cross-bred male offspring are supplied to Madras and the Nilgiri hills. The cattle-breeding farm at Chintaladevi in the Nellore District is maintained for the breeding of Ongole cattle which is the most valuable of the Madras breeds. On the buffalo-breeding farm at Guntur, she-buffaloes of the local breed are being mated with bulls of the Murra breed. At the Coimbatore College Dairy Farm experiments in cross-breeding are being made. From the different farms in the Presidency 19 stud bulls were sold during the year.

The grading up of MYSORE cattle for milk yield is being pursued at Hebbal. The Scindi has proved to be the most suitable milch cow for the TRAVANCORE State, and a herd of this breed is being maintained at Trivandrum. On another farm in the south of the State, attention is being concentrated on the breeding of draught bullocks by mating local cows with Kangayam and Amrit Mahal bulls. In BARODA, herds of Gir cattle and Jafferabadi buffaloes are being built up.

Sheep-breeding. Experiments are being carried out in some provinces with a view to grading up the indigenous breeds of sheep by cross-breeding with Merino and other breeds. On the Hissar farm in the PUNJAB, ewes of the local breed are being crossed with Merino rams; the cross-bred rams are to be used for grading up the local sheep of the Kangra and Kulu valleys. The breed selected for distribution in the Mianwali District is the Damani. The mating of fat-tailed Pusht-i-Koh rams imported from Iraq with local Hashtnagari ewes has produced desirable crosses on the Tarnab farm in the NORTH-WEST FRONTIER PROVINCE; the half-

bred rams are much appreciated by the local shepherds. At Hosur in MADRAS the local breeds of pure white and black-faced white sheep are being graded up by selective breeding. Over a period of some twelve years the average yield of wool has been increased by about 100 per cent. Through the co-operation of the Kolar Sheep Breeders' Association a demand, far in excess of the supply, has arisen for cross-bred Merino rams in parts of the MYSORE State.

Poultry-breeding. The pioneer work done by the United Provinces Poultry Association, through the help of a substantial grant from the local Government, has stimulated the interest of other provinces in the possibilities of poultry-breeding. Special farms devoted to poultry-breeding have been started in the Punjab and Bombay, while broods of English birds have been established on agricultural stations in some other provinces.

CHAPTER IX.

PUBLICATIONS OF THE AGRICULTURAL DEPARTMENTS.

A complete list of agricultural publications issued during the year under review is given in Appendix XIII (page 135). Briefly summarized, those issued by the Imperial and Provincial Departments of Agriculture are as follows :—

Imperial. Twenty-three memoirs, eleven bulletins and ten other publications were issued during the year, while 25 publications were in the press on 30th June, 1928. The publications issued dealt with subjects of general interest such as the improvement of varieties of rice, *juar*, *bajra* and cotton, digestibility trials on Indian feeding stuffs, etc. A revised fourth edition of the Bulletin on Lac and a second edition of the Memoir on Indian Cottons were sent to the press during the year. " The Agricultural Journal of India," which is issued every two months, and the quarterly journal entitled " The Journal of the Central Bureau for Animal Husbandry and Dairying in India " started in April 1927, continued to maintain their popularity among the classes of readers for whom they are intended.

Provincial. Fifteen bulletins and twenty-four leaflets with their vernacular versions were issued in BOMBAY. Among the subjects dealt with are dry farming methods suitable for the Deccan, the cultivation and manuring of tobacco, improved *gur*-making furnaces, green-manure crops suitable for the Konkan, and silage-making. The monthly digest of the operations of the MADRAS Agricultural Department continued to be published in English and the principal vernaculars of the Presidency. Over 82,000 copies of the Villagers' Calendar printed in five languages were distributed and sold. The methods of trapping crabs in paddy fields formed the subject of a leaflet, of which 25,000 copies were printed for free distribution. The publication of the quarterly journal of the BENGAL department is in abeyance, but leaflets on the manufacture of *gur*, silage and artificial farmyard manure

and the cultivation of sugarcane, potatoes and tobacco were issued. Two leaflets on the cultivation of maize and ground-nuts were published in BIHAR and ORISSA. In the UNITED PROVINCES, the publication of monthly agricultural journals in Hindi (Kisan Upakarak) and Urdu (Mufid-Ul-Mazarain) was continued. The occasional publications included one on the cold storage of potatoes. In addition to the half-yearly " Seasonal Notes ", the PUNJAB department published a number of leaflets dealing in particular with different aspects of poultry-breeding. Of the three bulletins issued in the CENTRAL PROVINCES, one has as its subject the scientific feeding of farm animals. The publications issued in BURMA dealt with the Lantana pest, homesteads and the marketing of crops. The Agricultural Calendar was published in Burmese as usual and over 7,000 copies were distributed. The ASSAM department published a bulletin on fruit-culture and a leaflet on Guinea grass.

CHAPTER X.

RECEIPTS AND EXPENDITURE OF THE AGRICULTURAL DEPARTMENTS.

The total expenditure incurred by the Imperial Department of Agriculture during the financial year ending 31st March, 1928, was Rs. 14,54,512. The gross receipts of the Agricultural Research Institute, Pusa, from the sale of farm produce, cattle, milk, etc., and subscriptions to the Sugar Cable Service amounted to Rs. 98,520 and the receipts from the three dairy farms and one creamery to Rs. 3,30,528. The net expenditure incurred by the Imperial Department was thus Rs. 10,25,464.

	Rs.
General expenditure of the Pusa Institute (including the office of the Agricultural Adviser and Director)	2,45,990
Botanical Section	38,515
Chemical Section	61,749
Bacteriological Section	51,277
Mycological Section	44,046
Entomological Section	72,280
Agricultural Section	1,42,820
Sugar Bureau	29,283
Sugar Cable Service	22,678
Imperial Dairy Expert	50,557
Physiological Chemist	57,465
Sugarcane Expert	1,41,166
TOTAL	9,57,826

The receipts and expenditure of the three dairy farms and one creamery under the control of the Imperial Dairy Expert were

Rs. 3,30,528 and Rs. 4,96,686, respectively, for the financial year 1927-28.

Name of farm	Receipts	Expenditure
	Rs.	Rs.
Bangalore	1,21,826	1,56,159
Wellington	84,592	1,00,196
Karnal	83,446	1,24,506
Anand (Creamery)	40,664	1,15,825*
TOTAL	3,30,528	4,96,686

* Excluding Rs. 60,000 paid to the Army Department as the purchase price of the Creamery.

The following tabular statement shows the receipts and expenditure of the Provincial Departments of Agriculture for the year 1927-28. The respective figures for the previous year were Rs. 22,79,958 and Rs. 1,16,99,044.

Province	Receipts	Expenditure
	Rs.	Rs.
Bombay	2,59,700	17,08,600
Madras	2,91,711	17,67,179
Bengal	1,37,354	9,78,354
Bihar and Orissa	1,21,965	5,75,195
United Provinces	3,91,246	24,33,176
Punjab	7,70,455	24,93,154
Burma	97,859	8,79,635
Central Provinces	2,63,911	11,79,119
Assam	88,106	3,82,202
North-West Frontier Province	21,187	73,304
Baluchistan	13,950	18,376
TOTAL	24,57,444	1,24,88,294

A rise of eight lakhs in the gross expenditure of the Provincial Departments of Agriculture is a satisfactory feature of the above table. The provinces which have increased their expenditure to an appreciable extent are the Punjab, the United Provinces, Madras, Burma and the Central Provinces. Bengal and Bihar and Orissa are the two major provinces reporting a decrease.

APPENDIX I.

Areas under new and improved varieties of crops during 1927-28.

Name of Province	Name of crop	Advantages	Area in Acres						Remarks
			1927-28			1926-27			
			Departmental seed	Natural spread	Total	Departmental seed	Natural spread	Total	
Bombay	Cotton—								
	1027 A. L. F.	Lint fetches a premium of Rs. 15-25 per candy (798 lb.)	200,670	240,000	440,670	165,472	300,200	465,672	
	Neglectum roseum	Early ripening; avoids frost; yields Rs. 7 more per acre.	9,243	200,000	209,243	16,565	114,738	131,303	
	Dharwar No. 1	Uniform staple, higher ginning percentage, resistant to red leaf.	156,099	*	*	178,492	111,000	289,492	
	Gadag No. 1		58,310	43,700	102,010	63,000	62,000	125,000	
	Punjab-American 4-F. and 285-F.	Prolific, hardy, early, commands a premium of 12-25 per cent.	1,420	38,016	39,436	4,000	32,302	36,302	
	Desi 27 W. N.	Prolific, special rough feel, bright colour, higher ginning percentage.	8,715	40,000	48,715	7,100	20,000	27,100	
	1-A Cylindrical Boll type.	....	..	..	..	10	..	10	
	Groundnut	Early maturing, profitable rotation crop.	497	362,796	363,293	1,640	289,517	291,157	
	Sugarcane (Red Mauritius and Manjav).	Higher yield of cane and *gur*, do not lodge, not attacked by jackals, free from red rot.	282	2,350	2,632	217	2,320	2,537	
	Bajra (Akola)	Better quality grain and higher yield	2,148	..	2,148	417	..	417	
	Wheat (Pusa 4 and Buxi)	Better yield and less affected by smut.	1,573	14,500	16,073	1,445	14,500	15,945	
	Paddy (selected strains of Kolamba).	Higher yielding capacity	5,400	*	*	4,562	185,070	189,632	
	Miscellaneous	....	437	805	1,242	501	530	1,031	

* Figures omitted as those received appear to be unreliable.

Areas under new and improved varieties of crops during 1927-28—contd.

Name of Province	Name of crop	Advantages	Area in Acres						Remarks
			1927-28			1926-27			
			Departmental seed	Natural spread	Total	Departmental seed	Natural spread	Total	
Madras	Paddy	Better yielders and more profitable to cultivators.	11,392	91,065	102,457	7,420	138,367	145,787	
	Sugarcane		3,286	5,521	8,807	485	10,961	11,446	
	Cotton		48,968	266,380	315,848	74,236	319,076	393,312	
	Miscellaneous		11,776	44,183	55,959	19,530	31,652	51,182	
Bengal	Paddy (Indrasail, Dudshar and Kataktara).	Capable of largely increased yields as compared with local paddy.	5,670	127,397	133,067	18,592	120,417	139,009	
	Jute (D. 154 and Chinsura Green).	Heaviest yielding types	46,326	937,889	984,215	83,840	416,376	500,216	
	Sugarcane (Tanna and Co. 213).	Drought resistant, resists water-logging, jackals and pigs; free from disease.	15,000	55,000	70,000	10,000	40,000	50,000	
	Other crops	More profitable to cultivators	553	16,360	16,913	222	621	844	
Bihar and Orissa	Paddy (Dahia, Kakharua, Badshabhog, Buromal, etc.).	Heavy yield	1,206	23,552	24,758	989	5,119	6,108	
	Sugarcane (Co. 205, 210, 213, 214, M. 2, Red Tanna.)	Greater outturn in cane and sugar	1,154	9,122	10,276*	522	5,915	6,436	*The total area under Coimbatore canes has been independently estimated at 15,000 acres for North Bihar only.
	Groundnut (No. 17)	Profitable crop even on poor land	97	1,698	1,795	95	1,771	1,866	
	Tobacco (Pusa 28)	Heavy yield and suitable for local consumption.	10	150	160	40	100	140	
	Gram (Saboor No. 4, Pusa No. 17).	Heavy yield	170	257	427	142	2	144	
	Wheat (Pusa 4, 12, 100, 52, 80-5).	Greater yield	153	1,845	1,998	135	2,348	2,483	
	Linseed	....	10	8	18	..	..	..	
	Wheat (Pusa 4, 12, 52, 54, 110, C. 13, 46 Muzaffarnagar, etc.).	High yielding and rust resisting; not liable to lodge as *desi* varieties.	65,000	1,050,000	1,115,000	50,000	950,000	1,000,000	

United Provinces	Cotton (J. N. 1, K. 22, A. 19, A. W. F., C. 204 and 1031, American cotton, etc.).	Superior to *desi* cotton; better lint and higher ginning percentage.	10,000	200,000	210,000	10,000	200,000	210,000
	Sugarcane (S. 48, Co. 205, 213, 214, 290, Uba, Barbados, Mauritius 16, etc.).	Give more outturn of cane per acre and 50 per cent. of *gur* more than the local varieties.	10,000	125,000	135,000	15,000	100,000	115,000
	Barley (Ballia, etc.)	Better yielder than local varieties	27,000	9,000	36,000	22,000	2,000	24,000
	Gram (Pusa yellow, black, etc.)	Produce and quality better than local varieties.	24,000	22,000	46,000	20,000	20,000	40,000
	Miscellaneous (Jaunpur maize, Cawnpore Dudania *juar*, awned *bajra*, large Japanese and Virginian bunch groundnuts, jute, etc.)	Better yielders than local varieties	44,000	38,000	82,000	36,000	30,000	66,000
Punjab	Cotton—							
	American 4 F.	Long-stapled variety, yields more than *desi* cottons and fetches a premium of Rs. 3-6 per maund of seed cotton.	188,566	536,744	725,310	180,960	941,040	1,122,000
	American 285 F.	Spins finer than 4 F. and also more drought-resistant and earlier.	1,860	3,740	5,600	3,200	6,700	9,900
	Desi No. 24	Improved *desi* variety	65,147	201,113	266,260	23,900	119,100	143,000
	White-flowered neglectum.	More yield and higher lint percentage	25,540	110,120	135,660	23,780	104,920	128,700
	Wheat (Punjab 11, 17, 8 A, Pusa 4, 12).	More yield, fetch better price, possess good milling and baking qualities, ripen early.	37,606	1,821,704	1,859,310	85,285	1,355,004	1,440,289
	Sugarcane (Bihar, Co. 205 and 223).	High yield	3,748	22,055	25,803	4,805	2,846	7,651
Burma	Paddy	Higher yield, freedom from red grain and higher milling outturn.	148,473	170,527	319,000	141,138	146,801	287,939
	Groundnut	High oil capacity, early maturity, good yield, easy to harvest.	1,106	24,251	25,357	2,231	19,976	22,207
	Cotton (Indigenous selection and Cambodia).	Longer and finer staple, higher ginning percentage.	4,497	745	5,242	3,558	1,400	4,958
	Gram	Immunity to wilt disease and higher yield.	10,720	131,923	142,643	4,860	70,304	75,164

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Areas under new and improved varieties of crops during 1927-28—concld.

Name of Province	Name of crop	Advantages	Area in Acres						Remarks
			1927-28			1926-27			
			Departmental seed	Natural spread	Total	Departmental seed	Natural spread	Total	
Central Provinces	Wheat	Better yielders	..	..	195,171	..	..	135,148	Figures based on seed farms only. Actuals under improved seed 3-4 times the figures.
	Paddy		..	..	163,364	..	..	104,256	Ditto.
	Cotton		..	..	469,144	..	..	500,019	Largely based on seed issued from recognized seed farms.
	Juar (Sorghum)		..	..	108,077	..	..	80,482	
	Groundnut		..	..	49,554	..	..	44,262	
	Other crops		..	..	7,828	..	..	7,122	
Assam	Paddy	Higher yielders than *desi* varieties	835	9,755	10,590	879	8,937	9,816	
	Jute		515	4,375	4,890	1,015	3,828	4,843	
	Sugarcane		141	2,810	2,951	77	2,242	2,319	
	Potato		1,545	2,078	3,623	4,966	5,270	10,236	
North-West Frontier Province.	Wheat (Pusa 4)	Ripens early, yields well, does not lodge, resists rust.	..	..	330,000	..	..	300,000	
	Sugarcane (Red Assami).	Ripens early, is vigorous and little affected by diseases and insects.	..	..	600	..	..	600	
	Berseem	Yields better than shaftal and is less liable to cause hoven.	..	..	12,000	..	..	10,000	
	Fruits	Superior varieties	..	..	3,000	..	..	1,000	
	Maize	Ditto	..	..	6,000	..	..	5,000	

APPENDIX II.

List of Agricultural Stations in British India in 1927-28.

Province	Agricultural Station	Area in acres	Officer in immediate charge	Supervising Officer	REMARKS
Bombay	Surat	292	Superintendent	...	Cotton and *juar* research station.
	Amalsad	19	Agricultural Overseer		Sugarcane farm.
	Nadiad	10	Tobacco Breeder	Deputy Director of Agriculture, Gujarat, Surat.	Tobacco farm.
	Broach	6	Cotton Breeder, South Gujarat.		Cotton and *juar* farm.
	Dohad	68	Superintendent		Cotton farm.
	Viramgam	6	Cotton Breeder, North Gujarat.		Wagad cotton breeding.
	Dhulia	28	Headmaster, Vernacular Agricultural School.	Deputy Director of Agriculture, North Central Division, Nasik.	Vernacular Agricultural School.
	Sangvi	49	Manager		Cattle breeding farm.
	Jalgaon	204	Superintendent		Seed farm.
	Kopargaon	26	Ditto	Deputy Director of Agriculture, South Central Division, Poona.	Sugarcane station.
	Baramati	21	Ditto		Sugarcane farm.
	Manjri	72	Ditto		Ditto
	Mohol	55	Overseer	Deputy Director of Agriculture, Southern Division, Dharwar.	
	Dharwar	143	Superintendent		
	Gokak Canal (Arbhavi)	62	Ditto		
	Mugad	9	Ditto		Rice breeding farm
	Tegur	370	Fieldman		Cattle breeding farm.
	Chharodi	2,251	Manager	Livestock Expert to Government, Bombay, Poona.	Kankrej cattle breeding farm.
	Bankapur	256	Ditto		Amrit Mahal cattle breeding farm.

List of Agricultural Stations in British India in 1927-28—contd.

Province	Agricultural Station	Area in acres	Officer in immediate charge	Supervising Officer	Remarks
Bombay	Ratnagiri	93	Superintendent	Deputy Director of Agriculture, Konkan, Ratnagiri.	Rice and *nagli* breeding farm.
	Kumta	22	Ditto		
	Karjat	9	Rice Specialist		
	Karjat	6	Superintendent	Crop Botanist to Government, Bombay, Poona.	Rice breeding station.
	Kirkee	2	Ditto		Wheat breeding station.
	Karachi (Willingdon Cattle Farm).	800	Manager	Deputy Director of Agriculture, Sind, Karachi.	Scindi cattle breeding farm.
	Mirpurkhas	200	Superintendent		Cotton breeding farm.
	Mirpurkhas	60	Ditto		Fruit farm.
	Sukkur	30	Ditto		Buffalo breeding farm.
	Larkana	65	Ditto		Rice *juar*, and wheat breeding work.
	Jacobabad	300	Ditto		Wheat farm.
	Ganeshkhind, Kirkee	80	Ditto	Horticulturist to Government, Bombay, Poona.	Botanical garden.
	Modibag, Poona	11	Ditto		Teaching and research fruit farm.
	Poona	275	Ditto	Professor of Agriculture, Poona Agricultural College.	Agricultural College farm.
	Kirkee	363	Manager		Agricultural College dairy.
	Coimbatore	314	Farm Manager	Principal, Agricultural College	Central farm attached to the Agricultural College.
	Samalkota	57	Ditto	Deputy Director of Agriculture, I Circle, Vizagapatam.	
	Anakapalle	36	Ditto		
	Hagari	225	Ditto	Deputy Director of Agriculture, III Circle, Bellary.	
	Nandyal	88	Ditto		
	Palur	64	Ditto	Deputy Director of Agriculture, IV Circle, St. Thomas Mount.	Groundnut station.
	Palakuppam	16	Ditto		

Madras	Kollipatti..	.125	Ditto	Cotton Specialist, Coimbatore	Cotton breeding station.
	Kasargod	106	Ditto	Deputy Director of Agriculture, VII Circle, Tellicherry.	West Coast coconut station.
	Taliparamba	86	Ditto		
	Vellalore	2	Ditto	Deputy Director of Agriculture, VIII Circle, Coimbatore.	Betel vine station.
	Nanjanad	86	Manager	Curator, Government Botanic Gardens, Ootacamund.	Seed potato farm.
	Coonoor, Burliar and Kallar	..	Assistant Manager		Pomological stations.
	Chintaladevi	850	Manager	Deputy Director, Live-stock, Hosur.	Cattle farm.
	Guntur	150	Ditto		Buffalo breeding station.
	Hosur	1,635	Ditto		Central cattle farm.
	Chinsura	210	Farm Superintendent	Deputy Director of Agriculture, Western Circle.	
	Burdwan	35	District Agricultural Officer		
	Berhampore	44	Ditto		
	Bankura	29	Ditto		
	Suri	33	Ditto		
	Krishnagar	37	Ditto		New farm.
	Jessore	5	Ditto		
	Gosaba	8	Agricultural Demonstrator		
Bengal	Decca	354	Chief Farm Superintendent	Deputy Director of Agriculture, Eastern Circle.	
	Mymensingh	20	District Agricultural Officer		
	Faridpur	20	Ditto		
	Comilla	20	Ditto		
	Barisal	20	Ditto		
	Kishoregunj	33	Ditto		
	Jamalpur	27	Ditto		
	Rangamati	15	Ditto		
	Dhanbari	7	Agricultural Demonstrator		
	Rajshahi	68	District Agricultural Officer	Deputy Director of Agriculture, Northern Circle.	

List of Agricultural Stations in British India in 1927-28—contd.

Province	Agricultural Station	Area in acres	Officer in immediate charge	Supervising Officer	Remarks
Bengal	Rangpur	19	District Agricultural Officer	Deputy Director of Agriculture, Northern Circle.	Demonstration farm.
	Bogra (old)	23	Ditto		
	Bogra (new)	6	Ditto		
	Pabna	20	Ditto		
	Dinajpur	24	Ditto		
	Mainaguri	25	Ditto		
	Malda	15	Ditto		
	Rangpur	333	Farm Superintendent	Live-stock Expert	Cattle farm.
	Rangpur	52	District Agricultural Officer	Agricultural Chemist	Tobacco farm.
	Kalimpong	76	Manager	Director of Agriculture.	
	Kalimpong		Superintendent of Sericulture.	Deputy Director of Sericulture	Sericultural research stations.
	Kurseong				
	Berhampore				
	Cuttack	150	Manager	Deputy Director of Agriculture, Orissa Range, Cuttack.	
	Khurda	31	Inspector		
	Balasore	75	Overseer		
	Angul	47	Ditto		
	Puri	42	Ditto		
	Anantpur	30	Ditto		
	Sepaya	379	Manager	Deputy Director of Agriculture, Western North Bihar Range, Sepaya.	
	Siwan	25	Overseer		
	Darbhanga	26	Ditto		

Bihar and Orissa	Sabour	190	Probationary Assistant Director of Agriculture.	Director of Agriculture.	
	Jamui	38	Inspector	Assistant Director of Agriculture, South-East Bihar Range, Monghyr.	Dairy[farm.
	Banka	26	Ditto		
	Monghyr	200	Manager		
	Gaya	193	Ditto	Deputy Director of Agriculture, South Bihar Range, Gaya.	
	Nawadah	67	Overseer		
	Bikramganj	24	Ditto		
	Siris	31	Ditto		
	Kanke	340	Manager	Deputy Director of Agriculture, Chota Nagpur Range, Kanke.	
	Netarhat	198	Overseer		
	Purulia	52	Inspector		
	Ramgarh	43	Overseer		
	Chianki	32	Ditto		
	Sambalpur	32	Inspector		
	Chaibassa	38	Ditto		
United Provinces	Shahjahanpur	163	Deputy Director	Deputy Director of Agriculture, Rohilkhand Circle.	
	Budaun	19	Overseer		
	Nawabganj (Bareilly)	119	Ditto		
	Nagina (Bijnor)	77	Superintendent		
	Cawnpore	71	Ditto	Deputy Director of Agriculture, Central Circle, Cawnpore.	
	Kalianpur (Cawnpore)	263	Ditto		
	Mainpuri	53	Ditto		
	Etawah	61	Ditto		
	Hardoi	55	Ditto		
	Atarra (Banda)	171	Ditto	Deputy Director of Agriculture, Bundelkhand.	
	Jaitpur (Hamirpur)	30	Overseer		
	Partabgarh	90	Superintendent	Deputy Director of Agriculture, Eastern Circle, Partabgarh.	

List of Agricultural Stations in British India in 1927-28—contd.

Province	Agricultural Station	Area in acres	Officer in immediate charge	Supervising Officer	Remarks
United Provinces	Naugawan (Sultanpur)	360	Superintendent	Deputy Director of Agriculture, Eastern Circle, Partabgarh.	
	Fyzabad	206	Ditto		
	Benares	78	Ditto		
	Aligarh	88	Ditto	Deputy Director of Agriculture, Western Circle, Aligarh.	
	Kalai (Aligarh)	142	Ditto		
	Muzaffarnagar	100	Ditto		
	Bichpuri (Agra)	100	Ditto		
	Jachonda (Muttra)	36	Inspector		
	Bulandshahr	25	Ditto		
	Gorakhpur	110	Overseer	Deputy Director of Agriculture, North Eastern Circle, Gorakhpur.	
	Bahraich	102	Ditto		
	Jeolikote (Naini Tal)	51	Ditto	Deputy Director of Agriculture, Hill Circle.	
	Lyallpur Agricultural Farm	430	Manager	Professor of Agriculture, Punjab, Lyallpur.	
	Lyallpur Students' Farm	78			
	Lyallpur Botanical Farm and Fruit Garden.	115	Associate Professor of Botany, Cerealist, Fodder Specialist, Millet Botanist and Fruit Specialist.	Associate Professor of Botany.	
	Risalewala	858	Manager	Professor of Agriculture	Mainly a seed farm.
	Risalewala Cotton Research Botanist's Farm	220	Assistant Cotton Research Botanist.	Cotton Research Botanist, Lyallpur.	Cotton experiments.
	Jhang	200	Manager	Deputy Director of Agriculture, Lyallpur.	Seed and demonstration farm.

Punjab	Fetna	500	Agricultural Assistant	Deputy Director of Agriculture, Montgomery.	Seed farm.
	Montgomery	549	Manager		Experimental farm.
	Shergarh	261	Ditto		Seed farm.
	Harappa Road	558	Agricultural Assistant		For reclamation of saline soils.
	Gurdaspur	263	Ditto	Deputy Director of Agriculture, Gurdaspur.	Experimental farm.
	Beas	43	Ditto		Demonstration farm.
	Gujranwalla	100	Ditto		District farm.
	Kala Shah Kaku	146	Ditto		Rice breeding station.
	Sargodha	657	Manager	Deputy Director of Agriculture, Rawalpindi.	Experimental station and seed farm.
	Chillianwala	250	Ditto		Seed farm.
	Gujrat	50	Agricultural Assistant		District farm.
	Campbellpur	100	Ditto		Ditto.
	Rawalpindi	252	Manager		Ditto.
	Hansi	589	Agricultural Assistant	Deputy Director of Agriculture, Hansi.	Experimental station.
	Sirsa	419	Ditto		Ditto.
	Ferozepore	100	Ditto		District farm.
	Gurgaon	100	Ditto		Ditto
	Rohtak	100	Ditto		Ditto
	Ambala	99	Ditto		Ditto
	Multan	529	Ditto	Deputy Director of Agriculture, Multan.	Experimental Station.
	Mianwali	207	Ditto		District farm.
	Dera Ghazi Khan	139	Ditto		Ditto
	Ludhiana	54	Ditto	Deputy Director of Agriculture, Jullundur.	Ditto
	Kangra	10	Ditto		Ditto
Central Provinces	Nagpur	268	Superintendent	Principal, Agricultural College, Nagpur.	College farm.
	Akola	271	Ditto	Economic Botanist, Nagpur.	

List of Agricultural Stations in British India in 1927-28—contd.

Province	Agricultural Station	Area in acres	Officer in immediate charge	Supervising Officer	Remarks
Central Provinces—*contd.*	Borgaon	368	Superintendent	Deputy Director of Agriculture, Western Circle, Amraoti.	
	Yeotmal	106	Ditto		
	Khandwa	177	Ditto		
	Basim	109	Ditto		
	Sindewahi	197	Ditto	Deputy Director of Agriculture, Southern Circle, Nagpur.	
	Tharsa	116	Ditto		
	Wara-Seoni	63	Ditto		
	Telinkheri	1,000	Ditto	Deputy Director of Agriculture, in charge Animal Husbandry, Nagpur.	Dairy farm.
	Raigarh (Garhi)	1,200	Ditto		Cattle breeding farm.
	Chandkhuri	333	Ditto	Deputy Director of Agriculture, Eastern Circle, Raipur.	
	Bilaspur	253	Ditto		
	Drug	281	Ditto		
	Raipur	229	Ditto		
	Seoni	164	Ditto	Assistant Director of Agriculture, Chhindwara.	
	Chhindwara	69	Ditto		
	Betul	161	Ditto		
	Powarkhera (Hoshangabad)	528	Ditto	Deputy Director of Agriculture, Northern Circle, Jubbulpur.	
	Adhartal (Jubbulpur)	637	Ditto		
	Saugor	161	Ditto		
	Damoh	152	Ditto		
	Mandalay	630	Senior Agricultural Assistant.	Professor of Agriculture, Mandalay Agricultural College.	Central farm.
	Tatkon	106	Ditto		Experimental farm.
	Pyinmana	55	Ditto	Deputy Director of Agriculture, East Central Circle.	Central farm.
	Pyu	146	Ditto		Seed farm.

Burma	Mahlaing	254	Ditto	Deputy Director of Agriculture, Myingyan Circle.	Central farm.
	Kyemohon	480	Ditto		Seed farm.
	Magwe	204	Ditto	Deputy Director of Agriculture, West Central Circle.	Ditto.
	Allanmyo	144	Ditto		Central farm.
	Pwinbyu	137	Ditto		Experimental and seed farm.
	Sa-aing	11	Junior Agricultural Assistant.		Tobacco farm.
	Hmawbi	456	Senior Agricultural Assistant.	Deputy Director of Agriculture, Southern Circle.	Central farm.
	Pegu	130	Ditto		Seed farm.
	Paungde	126	Ditto		Ditto.
	Akyab	138	Ditto	Deputy Director of Agriculture, Arakan Circle.	Central farm.
	Kyaukpyu	23	Ditto		Experimental farm.
	Myaungmya	92	Senior Agricultural Assistant.	Deputy Director of Agriculture, Irrawaddy Circle.	Central farm.
	Henzada	148	Ditto		Seed farm.
	Maubin	155	Ditto		Ditto.
	Kanbalu	537	Senior Agricultural Assistant.	Deputy Director of Agriculture, Northern Circle.	Central farm.
	Padu	105	Junior Agricultural Assistant.		Experimental farm.
	Shwebo	84	Senior Agricultural Assistant.		Seed farm.
	Mudon	88	Ditto	Deputy Director of Agriculture, Tenasserim Circle.	Central farm.
	Thaton	195	Ditto		Seed farm.
	Paukkaung	16	Ditto	Entomologist	Experimental farm for mulberry plantation.
Assam	Jorhat	59	Manager	Deputy Director of Agriculture, Assam.	Sugarcane station.
	Titabor	120	Ditto		Rice station.
	Upper Shillong	367	Ditto		Potato station.
	Karimganj	80	Ditto		Rice station.
	Khanapara	200	Ditto		Cattle breeding farm.

List of Agricultural Stations in British India in 1927-28—concld.

Province	Agricultural Station	Area in acres	Officer in immediate charge	Supervising Officer	Remarks
North-West Frontier Province	Tarnab (Peshawar)	200	Manager	Agricultural Officer, North-West Frontier Province, Tarnab.	
	Haripur (Hazara)	20	Ditto		
Imperial Department of Agriculture	Pusa	830	Overseer	Imperial Agriculturist.	
	Bangalore	201	Superintendent	Imperial Dairy Expert	Dairy farms.
	Wellington	60	Ditto		
	Karnal	2,154	Ditto		
	Coimbatore	90	Farm Manager	Government Sugarcane Expert	Imperial Sugarcane Station.

APPENDIX III.

Staff of the Provincial Departments of Agriculture in India during 1927-28.

Province	RESEARCH AND TEACHING STAFF						DISTRICT STAFF					
	SUPERIOR SERVICE (IN AND OUTSIDE I. A. S.)		PROVINCIAL SERVICE		SUBORDINATE SERVICE		SUPERIOR SERVICE (IN AND OUTSIDE I. A. S.)		PROVINCIAL SERVICE		SUBORDINATE SERVICE	
	Sanctioned cadre	Filled substantively	Sanctioned cadre	Filled substantively	Sanctioned cadre	Filled substantively	Sanctioned cadre	Filled substantively	Sanctioned cadre	Filled substantively	Sanctioned cadre	Filled substantively
Bombay	6	6	15	15	28	28	8	8	9	9	272	272
Madras	12	9	17	17	193	192	10	9	10	10	162	137
Bengal.	6	5	4	3	31	31	3	1	5	4	158	146
Bihar and Orissa . . .	..	..	3	3	2	1	12	6	11	10	77	73
United Provinces . . .	9	5	9	9	36	36	12	4	18	18	124	124
Punjab	20*	16†	14‡	14	56	56	8	7	17	17	474	423
Central Provinces . . .	5	4	6	6	22	18	9	5	10	10	117	117
Burma.	5	3	7	5	18	12	12	8	12	7	84	49
Assam	2	1	..	..	5	5	3	1	3	3	21	21
North-West Frontier Province	1	1	..	..	6	5	..	..	..	..	..	..

* Includes 10 temporary posts.
† „ 11 „ „
‡ „ 1 „ post.

APPENDIX IV.

Showing results of well boring during 1927-28.

Province	1927-28		1926-27	
	Number of bores	Number successful	Number of bores	Number successful
Bombay	312	181	193	113
Madras	843	572	768	584
Bengal	28	28	21	14
Bihar and Orissa	366	290	184	179
United Provinces	939	699	1,017	759
Punjab	725	608	584	476
Central Provinces	1	..	2	..

APPENDIX V.

Showing sale of improved implements through departmental agency during 1927-28.

Province	Ploughs		Cane Mills		Fodder Cutters		Hoes		Other Implements		Spare Parts	
	1927-28	1926-27	1927-28	1926-27	1927-28	1926-27	1927-28	1926-27	1927-28	1926-27	1927-28	1926-27
Bombay	768	174	35	52	13	23	56	7	256	383	464	344
Madras	2,424	1,985	31	26	56	44	39	2	341	192	3,784	3,426
Bengal	10	10	12	6	..	2*	2	5	12	1	3	..
Bihar and Orissa . . .	42	..	6	..	2	4	..	..	54	..	5	..
United Provinces . .	3,787	3,321	119	113	47	50	64	15	141	320	7,208	5,895
Punjab	8,840	7,868	278	612	3,310	2,797	369	130	3,848	2,249	2,407	2,545
Central Provinces . .	5,780	4,474	152	240	48	19	210	402	749	500	9,002	7,618
Burma	2,950	2,584	2	9	5	4	23	10	144	40	1,712	482
Assam	1	14	150	184	..	..	..	..	45	52	16	..
North-West Frontier Province	2	..	..	..	..	..	..	..	..	..	2	..

* Revised figure.

APPENDIX VI.

Improved seed and manures distributed through departmental agency during 1927-28.

Province	SEED DISTRIBUTED						MANURES DISTRIBUTED			
	GRAIN SEED IN CWT.		WHOLE CANES (No.)		FRUIT PLANTS (No.)		COMMERCIAL FERTILIZERS IN CWT.		CAKES IN CWT.	
	1927-28	1926-27	1927-28	1926-27	1927-28	1926-27	1927-28	1926-27	1927-28	1926-27
Bombay	29,357	3,497	93,790	56,389	52,469	46,508	3,332	786	309	560
Madras	10,932	16,925	14,504	6,218,480 +674 cwt.	21,821	33,771	54,286	14,415	8,924	83,723
Bengal	3,358	4,903	1,745,083	1,402,000	260	288	1,279	506	496	100
Bihar and Orissa	1,770	..	19,110	..	912	..	8,700	..	..	..
United Provinces	55,657	50,230	96,242 cwt.	117,680 cwt.	15,829	31,054	2,388	1,800	6,033	7,580
Central Provinces	179,300	178,195	818,102	1,112,025	5,069	2,347	659	409	514	308
Burma	34,415	32,303	21,825	36,520	282	300	208	46	..	..
Assam	3,104	3,377	157,688	67,750	4,102	1,988	1,454	1,169	91	70
North-West Frontier Province	215	140	23 cwt.	15 cwt.	13,000	30,000	..	..	..	..

NOTE.—Figures for the Punjab are not available.

APPENDIX VII.

Demonstration and propaganda work during 1927-28.

Province	Number of agricultural shows held		Number of practical demonstrations carried out		Number of illustrated lectures given	
	1927-28	1926-27	1927-28	1926-27	1927-28	1926-27
Bombay	70	36	1,282	1,402	130	66
Madras	125	282	5,430	4,683	241	214
Bengal	23	17	2,014	1,237	65	60
Bihar and Orissa	2	..	2,964	1,212	..	2
United Provinces	82	68	18,377	32,774	92	65
Central Provinces	47	34	4,339	3,446	231	54
Burma	20	26	1,241	1,017	114	386
Assam	5	5	1,020	2,200	..	26
North-West Frontier Province	..	..	3	3	..	8

NOTE.—Figures for the Punjab are not available.

APPENDIX VIII.

Agricultural Colleges and Schools in British India during 1927-28.

Name of College or School	Courses of instruction	1927-28				1926-27				Remarks
		Applications for admission	Admissions made during the year	Total number on the roll	Number passed in final examination	Applications for admission	Admissions made during the year	Total number on the roll	Number passed in final examination	
					(a) Post-graduate Training Institutions.					
Agricultural Research Institute, Pusa.	Two-year Post-graduate Course.	35	4	11	5	35	1	10	4	
Imperial Institute of Animal Husbandry and Dairying, Bangalore.	(1) (*a*) Fifteen-month Post-graduate Course.	..	4	9	5	..	5	6	1	
	(*b*) Twenty-four month course.	1	1	1	..	..	..	..	..	
	(2) Two-year Indian Dairy Diploma Course.	48	27	49	18	9	9	33	5	
	(3) Short Courses, Animal Husbandry and Dairying for varying periods.	16	16	16	16	17	17	17	17	
					(b) Provincial Agricultural Colleges.					
Agricultural College, Poona.	(1) Three-year B. Ag. Degree Course.	168	72	199	38	135	110	201	27	Affiliated to the University of Bombay.
	(2) College Diploma Course.	..	..	..	3	..	..	..	..	
Agricultural College, Coimbatore.	Three-year B.Sc. Ag. Degree Course.	176	41	106	18	214	40	82	19	Affiliated to the University of Madras.
Agricultural College, Cawnpore.	(1) Four-year L. Ag. Diploma Course.	152	44	111	9	127	34	92	9	
	(2) Two-year Certificate Course.	105	31	44	13	58	26	56	27	

Punjab Agricultural College, Lyallpur.	(1) Four-year B.Sc. Ag. Degree Course.	450	68	233	16	439	83	220	30	Affiliated to the University of Punjab.
	(2) One-and-a-half year M.Sc. Degree Course.	4	2	4	..	1	1	2	..	
	(3) Two-year Certificate Course.	..	..	23	21	..	..	23	20	
	(4) Six-month Vernacular Course (Summer class).	125	40	39	..	85	45	39	37	
	(5) Six-month Vernacular Course (Winter class).	154	41	41	40	70	42	42	38	
	(6) One-month Rural Economy Course.	30	30	30	30	15	15	15	15	
	(7) Ten-and-a-half month Teachers' Training Course.	42	32	30	30	45	34	32	32	
	(8) Six-week Blacksmith class.	66	20	20	17	42	22	14	14	
Agricultural College, Nagpur.	(1) Four-year Degree Course.	94	46	88	..	173	64	70	..	Affiliated to Nagpur University.
	(2) Four-year College Diploma Course.	..	..	12	8	..	..	27	7	
	(3) Two-year Certificate Course.	18	7	16	5	16	9	19	7	
Agricultural College, Mandalay.	Three-year Diploma Course.	60	24	50	9	35	18	40	11	
Bombay.				(c) *Agricultural Schools.*						
Vernacular Agricultural School, Loni Kalbhor (in Marathi).	Two-year Course . .	159	25	45	22	105	26	48	14	
Vernacular Agricultural School, Devlhosur (in Kanarese).	Ditto . .	75	17	30	9	75	17	31	14	
Vernacular Agricultural School, Jambul (in Marathi).	Ditto . .	13	13	24	10	45	20	22	9	
Vernacular Agricultural School, Godhra (in Gujarati).	Ditto . .	34	16	30	26	51	16	30	11	
Vernacular Agricultural School, Dhulia (in Marathi).	Ditto . .	80	17	30	11	45	16	32	10	

Agricultural Colleges and Schools in British India during 1927-28—concld.

Name of College or School	Courses of instruction	1927-28				1926-27				Remarks
		Applications for admission	Admissions made during the year	Total number on the roll	Number passed in final examination	Applications for admission	Admissions made during the year	Total number on the roll	Number passed in final examination	
Vernacular Agricultural School, Surat (in Gujarati).	Two-year Course . .	45	13	22	16	40	16	31	15	
Madras.										
Agricultural Middle School, Taliparamba.	Ditto . .	79	38	41	8	34	19	17	4	
Agricultural Middle School, Anakapalle.	Ditto . .	21	9	..	..	12	12	1	6	School closed in December, 1927.
Bengal.										
Secondary Agricultural School, Dacca.	Two-year course for regular students and one-year course for Demonstrators.	27	26	11	3	33	7	11	7	
United Provinces.										
Vernacular Agricultural School, Bulandshahr.	(1) Two-year Vernacular Course.	72	36	67	30	55	36	87	16	
	(2) Teachers' Training class.	13	13	13	11	..	..		11	
	(3) Fieldmen's Course .	14	10	8	4	18	7		7	
	(4) Engine Drivers' Course.	13	10	10	3	12	5		4	
Punjab.										
Agricultural Vernacular Class, Gurdaspur.	(1) Six-month Vernacular Course (Summer class).	125	58	48	46	..	..	..	..	
	(2) Six-month Vernacular Course (Winter class).	210	54	52	48	..	..	..	..	

Agricultural Vernacular Class, Hansi.	(1) Six-month Vernacular Course (Summer class).	50	42	22	..	65	47	10	17	
	(2) Six-month Vernacular Course. (Winter class.)	40	31	25	22	145	45	27	23	
Central Provinces.										
Agricultural Middle School, Powarkhera.	Four-year Course . .	52	32	69	10	52	41	53	3	
Burma.										
Agricultural School, Pyinmana.	Four-year Course . .	..	60	60	8	..	64	55	18	The school is run by the American Baptist Mission and subsidized by Government.
Central Farm School, Hmawbi.	(1) Horticultural class .	..	10	8	5	10	10	10	5	
	(2) Short courses of practical instruction.	..	35	35	..	..	80	80	..	
Central Farm School, Mahlaing.	(1) Short course of practical training for 9 months.	..	10	10	9	..	..	..	..	
	(2) Short courses of practical instruction.	..	28	28	..	..	13	13	13	
Central Farm School, Tatkon.	Short courses of practical instruction.	..	2	2	...	2	2	2	..	
Central Farm School, Padu.	Ditto .	..	2	2	..	22	10	10	..	
Central Farm School, Allanmyo.	Ditto .	..	10	10	..	..	..	..	..	

APPENDIX IX.

Operations of Non-Credit Agricultural Co-operative Societies in British India during 1927-28.

The two tables below include Agricultural Societies for—

A. 1. *Purchase and Purchase and Sale.* These are societies intended to facilitate the purchase of agricultural requisites for members, such as societies which purchase seed, manure, implements, etc., for sale to their members. Societies of this character which collect for joint sale the produce of members without making this their main object are also included in this class.

2. *Production.* These are societies which have for their chief object an act of production without proposing to themselves sale as a direct object. These also include societies for joint irrigation, for collective use of machinery, for assistance in horse and cattle breeding, etc.

3. *Production and Sale.* This class includes societies in which these two functions are united or in which one or the other predominates, it being impossible to make a clear distinction between them. It covers all societies whose main object is the joint sale of any commodity whether such commodity is produced or worked up or prepared for sale by the society itself or by the members individually. It comprises all co-operative creameries and distilleries, as well as societies whose main object is the sale of grain, cattle, eggs, *ghi*, etc., produced by their members.

4. Other forms of co-operation except insurance.

B. Insurance.

Operations of Non-Credit Agricultural Co-operative Societies in British India during 1927-28.

(A) PURCHASE, SALE AND PRODUCTION.

Province	Class of societies	Number of societies	Number of members	Sale of goods to members	Purchase of members' products	Working capital	Profit and loss for the year	REMARKS
				Rs.	Rs.	Rs.	Rs.	
Bombay	Purchase, and purchase and sale.	65	3,309	44,359	8,682	1,53,783	—6,263	
	Production	16	511	24	116	9,785	—563	
	Production and sale	81	13,959	3,24,835	7,46,972	13,02,313	+39,844	
	Others	95	54,987	26,107	16,943	59,785	—872	
	TOTAL	257	72,766	3,95,325	7,72,713	15,25,666	+32,146	
Madras	*Purchase, and purchase and sale.*	*127*	*11,907*	*1,55,777*	..	6,18,922	—16,345	
	Production and sale	26	1,569	5,344	..	1,86,225	—15,963	
	Others	348	20,677	45,603	..	3,90,629	—554	
	TOTAL	510	34,153	2,06,724	..	11,95,776	—32,862	
Bengal	Purchase, and purchase and sale.	85	26,867	56,19,528	55,80,611	18,74,501	—4,20,093	
	Production	525	15,195	143	..	3,13,485	—12,542	
	Production and sale	126	9,210	2,87,913	8,28,153	7,84,400	+1,84,116	
	Others	33	9,107	18,756	13,706	68,515	—403	
	TOTAL	769	60,379	59,26,340	64,22,470	30,40,901	—2,48,922	

Operations of Non-Credit Agricultural Co-operative Societies in British India during 1927-28—concld.

(A) PURCHASE, SALE AND PRODUCTION—*concld.*

Province	Class of societies	Number of societies	Number of members	Sale of goods to members	Purchase of members' products	Working capital	Profit and loss for the year	REMARKS
				Rs.	Rs.	Rs.	Rs.	
Bihar and Orissa	Purchase, and purchase and sale.	4	421	3,140	2,374	5,977	—911	
	Production	4	101	..	..	4,475	..	
	Production and sale	10	167	1,775	..	15,462	—2,356	
	Others	2	24	..	..	1,133	+4	
	Grain golas	87	31,806	..	..	1,81,447*	+2,537†	† and 88,253 mds. of grain.† and profit. of 13,731 mds. of grain.
	TOTAL	107	32,519	4,915	2,374	2,08,494	—726	
United Provinces	Production and sale	2	12	..	3,796	4,059	—54	
	Others	14	34	8	72	207	+34	
	TOTAL	16	46	8	3,868	4,266	—20	
Punjab	Purchase, and purchase and sale.	15	1,172	93,293	95,023	36,688	+11,241	
	Production	226	5,284	..	..	6,507	+347	
	Production and sale	573	26,101	26,71,042	32,78,503	5,60,018	+17,107	
	Others	47	954	..	..	55,323	+ 3,083	
	TOTAL	861	33,511	27,64,335	33,73,526	6,58,416	+31,778	

Burma	Purchase, and purchase and sale.	19	1,332	42,075	16,189	55,737	—2,982	
	Production	6	180	..	..	...	..	
	Production and sale	43	2,618	..	4,933	3,95,870	—79,755	
	TOTAL	68	4,130	42,075	21,122	4,51,607	—82,637	
Central Provinces and Berar.	Purchase and sale	16	1,154	57,767	..	85,297	+3,762	
	Production	4	44	..	979	1,318	..	
	Production and sale	4	429	6,349	..	16,935	+4,131	
	TOTAL	24	1,627	64,116	979	1,03,550	+7,893	
Assam	Production and sale	1	80	..	7,868	2,200	—939	
	TOTAL	1	80	..	7,868	2,200	—939	

(B) CATTLE INSURANCE.

Province	Number of societies	Amount of risk insured	Premia collected during the year	Supplementary contributions collected	NUMBER OF ANIMALS		Claims paid	Cost of management	Funds in hand at the end of year	Amount of risk re-insured	Amount or premia paid for re-insurance
					Insured	Lost					
		Rs.	Rs.				Rs.	Rs.	Rs.	Rs.	Rs.
Bombay	7	1,850	92	..	33	6	213	70	1,310	..	..
Madras	4	229	4	..	..	..	..	14	47	..	..
Burma	389	5,581	680	..	362	9	849	110	35,697	8,465	275
	1*	28,260	317	..	569	34	504	1,036	15,540	..	..

* Central Reinsurance Society.

APPENDIX X.

Showing the working of the Provincial Veterinary Departments during 1927-28.

Province	Reported mortality from contagious diseases			Dispensaries and Hospitals			District work					
	Rinderpest	Other diseases	Total	Number of institutions	Cases treated	Castrations performed	Cases treated	Castrations performed	Outbreaks in which inoculation was undertaken	Deaths uninoculated	Inoculations.	Deaths after inoculation
Bombay	1,982	6,049	8,801	105	199,446	16,691	39,250	9,199	322	3,532	34,425	59
Madras	35,803	40,486	76,289	99	133,149	3,968	60,290	4,553	1,177	23,064	209,267	767
Bengal	11,790	4,276	16,066	45	92,449	123	160,350	35	547	10,728	115,842	489
Bihar and Orissa	6,405	8,356	14,761	31*	66,474	1,675	167,491	27	1,328	6,166	245,532	419
United Provinces	30,742	10,450	41,192	155	286,490	2,935	88,236	246	2,007	23,972	222,655	189
Punjab	26,774	15,755	42,529	242	912,604	128,863	220,039	143,322	2,561	11,896	649,771	285
Burma	38,385	3,570	41,955	5	13,805	22	143,534	7	660	16,157	96,070	896
Central Provinces	14,106	6,794	20,900	98	267,217	4,981	298,669	51,428	829	7,862	103,863	232
Assam	14,401	16,704	31,105	8	4,275	102	73,474	1,663	284	5,380	17,087	163
North-West Frontier Province	1,983	2,574	4,557	18	68,484	8,213	31,153	27,764	80	1,257	13,765	7
Sind	2,911	1,771	4,682	18	31,150	442	7,125	1,850	163	1,762	15,997	36
Baluchistan	133	8,665	8,798	10	25,704	135	21,986	33	10	1,251	2,781	48
Rajputana	..	87	87	2	4,860	19	132	..	..	..	..	..
Total for 1927-28	185,415	125,537	311,222	831	2,106,107	168,169	1,320,729	240,127	9,968	113,027	1,727,055	3,590
Total for 1926-27	203,717	118,614	322,331	786	1,904,478	133,288	1,226,256	210,155	8,842	121,343	1,527,213	6,160

* There are also 96 dispensaries, the working of which is shown under District work, in columns 8 and 9.

APPENDIX XI.

Showing the details as to Students of Veterinary Colleges and Schools in India during 1927-28.

Veterinary College or School.	Course of instruction	Number of Students						Students admitted during the year, classed by educational qualifications		
		Admitted during the year		Passed final examination during the year	Failed to pass final examination	Remaining under instruction at end of the year		Matriculates, school finals or with higher qualifications	Knowing some English but not matriculates	Knowing no English or very little English
		Scholarship holders	Others			In ordinary course	Instruction prolonged by reason of failure to pass			
Bombay Veterinary College.	3 years' English Course.	7	35	18	10	83	15	26	16	..
Bengal Veterinary College	Do. . .	30	27	30	10	81	33	45	12	..
Madras Veterinary College.	Do. . .	15	23	19	3	48	18	38	..	..
	Post Diploma Course.	8	..	7	1	..	..	..	..	..
Punjab Veterinary College.	4 years' English Course.	10	37	8	8	68	38	47	..	..
	Post Diploma Course.	2	..	..	..	..	..	..	..	..
Insein Veterinary School .	3 years' Vernacular Course.	..	..	..	..	13	..	..	..	..
Taunggyi Veterinary School.	1½ years' Vernacular Course.	..	..	..	..	..	..	..	..	Closed since July, 1927.

APPENDIX XII.

Showing the number of cattle issued from Government Farms during 1927-28.

Province	Bulls	Cows	Male buffaloes	She buffaloes	Young stock	Total for 1927-28	Total for 1926-27
Bombay	53	83	..	..	68	204	274
Madras	19	25	2	5	14	65	64
Bengal	19	..	..	..	..	19	11*
Bihar and Orissa	36	78	1	14	30	158	49
United Provinces	593	..	42	..	..	635	264
Punjab	439	3	..	..	115	557	436
Burma	..	..	..	..	..	..	6
Central Provinces	61	206	3	5	188	523	276
Assam	9	13	..	..	..	22	12
North-West Frontier Province	5	..	..	..	..	5	..
Imperial Farms.							
Pusa	1	51	..	..	39	91	86
Karnal	2	28	..	..	12	42	30
Bangalore	1	12	..	..	21	34	58
Wellington	..	20	..	..	19	39	54

* Revised figure.

APPENDIX XIII.

List of Agricultural Publications in India during 1927-28.

No.	Title	Author	Where published
	GENERAL AGRICULTURE		
1	*The Agricultural Journal of India*, Vol. XXII, Parts IV, V and VI, and Vol. XXIII, Parts I, II and III. Price, Re. 1-8 or 2*s.* per part. Annual subscription, Rs. 6 or 9*s.* 6*d.*	Edited by the Agricultural Adviser to the Government of India.	Government of India Central Publication Branch, Calcutta.
2	The *Journal of the Central Bureau for Animal Husbandry and Dairying in India*, Vol. I, Parts II, III and IV and Vol. II, Part I. Annual subscription, Rs. 2-8; Single copy As. 10.	Ditto	Ditto.
3	Scientific Reports of the Agricultural Research Institute, Pusa (including the Reports of the Imperial Dairy Expert, Physiological Chemist, Government Sugarcane Expert, and Secretary, Sugar Bureau) for the year 1926-27. Price, Re. 1-14 or 3*s.* 3*d.*	Issued by the Agricultural Research Institute, Pusa.	Ditto.
4	Review of Agricultural Operations in India, 1926-27. Price, Rs. 2 or 3*s.* 6*d.*	Issued by the Agricultural Adviser to the Government of India.	Ditto.
5	Unit System for Farm Buildings. Pusa Agricultural Research Institute Bulletin No. 174. Price, As. 5 or 6*d.*	G. S. Henderson, N.D.A., N.D.D.	Ditto.
6	Annual Report of the Indian Central Cotton Committee, Bombay, 1927. Price, Rs. 2.	Issued by the Indian Central Cotton Committee, Bombay.	G. Claridge and Co., Ltd., Bombay.
7	Agricultural Statistics of India, 1925-26, Vol. I. Price, Re. 1-5 or 2*s.* 3*d.*	Issued by the Department of Commercial Intelligence and Statistics, India.	Government of India Central Publication Branch, Calcutta.
8	Agricultural Statistics of India, 1925-26, Vol. II. Price, Re. 1-4 or 2*s.*	Ditto	Ditto.
9	Statistical Abstract for British India with Statistics, where available, relating to certain Indian States from 1916-17 to 1925-26. Price, Rs. 2 or 3*s.* 9*d.*	Ditto	Ditto.

List of Agricultural Publications in India during 1927-28—contd.

No.	Title	Author	Where published
	GENERAL AGRICULTURE —*contd.*		
10	Report on the Administration of the Meteorological Department of the Government of India in 1926-27.	The Director General of Observatories.	Government of India Press, Simla.
11	How to use Crab traps in Paddy fields. Madras Department of Agriculture leaflet No. 47.	R. Venkatraman, Assistant Paddy Specialist.	Government Press, Madras.
12	A note on the Anakapalle Experiment Station, Vizagapatam District. Madras Department of Agriculture Leaflet No. 48.	Issued by the Department of Agriculture, Madras.	Ditto.
13	Note to assist identification of Karunganni and Uppam Cottons. Madras Department of Agriculture Leaflet No. 49.	Ditto .	Ditto.
14	History of certain crops from sowing to harvest and describing their vicissitudes under adverse seasonal conditions. Madras Department of Agriculture Bulletin No. 88.	Ditto .	Ditto.
15	Villagers' Calendar for 1928-29 (English, Tamil, Telegu and Kanarese).	Ditto .	Ditto.
16	Note on the Exhibits at the Agricultural Exhibition, IV Circle, comprising North Arcot, South Arcot, Chingleput and Chittoor Districts. Madras Department of Agriculture Leaflet No. 33, revised.	Ditto .	Ditto.
17	Annual Reports of the Experimental Stations, Madras, for 1927-28.	Ditto .	Ditto.
18	Report on the Operations of the Department of Agriculture, Madras, 1927-28, Vol. I.	Ditto .	Ditto.
19	Annual Report of Subordinate Officers for 1927-28, Vol. II.	Ditto .	Ditto.
20	The Conduct of Field Experiments. Madras Department of Agriculture Bulletin No. 89.	Ditto .	Ditto.

List of Agricultural Publications in India during 1927-28—contd.

No.	Title	Author	Where published
	GENERAL AGRICULTURE —*contd.*		
21	The Manurial Problem and its Solution.	Issued by the Department of Agriculture, Madras.	Government Press, Madras.
22	Year Book 1927 of the Department of Agriculture, Madras.	Ditto .	Ditto.
23	Annual Report of the Department of Agriculture in the Bombay Presidency for 1926-27. Price, Rs. 2-4.	Issued by the Department of Agriculture, Bombay.	Government Central Press, Bombay.
24	Annual Season and Crop Report of the Bombay Presidency for 1926-27. Price, Re. 1-11.	Ditto .	Ditto.
25	Sugarcane mills and small power crushers in the Bombay Presidency. Bombay Department of Agriculture Bulletin No. 139 of 1927. Price, As. 6-6.	Rao Bahadur P. C. Patil	Yeravda Prison Press, Yeravda.
26	Furnaces for making *gul* or crude sugar in the Bombay Presidency. Bombay Department of Agriculture Bulletin No. 144 of 1927. Price, As. 7-3.	Ditto .	Ditto.
27	Organisation and cost of *gul* making in the Deccan sugarcane tracts. Bombay Department of Agriculture Bulletin No. 147 of 1927. Price, As. 2-6.	Ditto .	Ditto.
28	Studies in the cost of production of crops in the Deccan. Bombay Department of Agriculture Bulletin No. 149 of 1927. Price, Re. 1-1-6.	Rao Bahadur P. C. Patil, T. G. Shirname and T. B. Pawar.	Ditto.
29	Tobacco cultivation in the Southern Maratha Country. Bombay Department of Agriculture Bulletin No. 140 of 1927. Price, As. 3.	S. S. Salimath . .	Ditto.
30	Trees and Shrubs for producing green manure in the Konkan and North Kanara. Bombay Department of Agriculture Bulletin No. 141 of 1927. Price, As. 3.	V. G. Gokhale and V. S. Habbu.	Ditto.

List of Agricultural Publications in India during 1927-28—contd.

No.	Title	Author	Where published
	GENERAL AGRICULTURE —*contd.*		
31	Dry Farming methods in the Deccan. Bombay Department of Agriculture Bulletin No. 142 of 1927. Price, As. 6-9.	V. A. Tamhane, N. V. Kanitkar, and G. M. Bapat.	Yeravda Prison Press, Yeravda.
32	Experiments on Cotton manuring in Khandesh. Bombay Department of Agriculture Bulletin No. 143 of 1927. Price, As. 1-3.	K. M. Pawar and N. G. Apte.	Ditto.
33	The origin, plan and progress of the Sakrand Agricultural Research Station, Sind. Bombay Department of Agriculture Bulletin No. 145 of 1927. Price, As. 4-3.	Dr. Harold H. Mann .	Ditto.
34	Culture of Guava and its improvement by selection in Western India. Bombay Department of Agriculture Bulletin No. 148 of 1927. Price, As. 7-3.	Dr. G. S. Cheema and G. B. Deshmukh.	Ditto.
35	Crops of the Bombay Presidency: their Geography and Statistics. Bombay Department of Agriculture Bulletin No. 146 of 1927. Price, Re. 1-11.	G. R. Ambekar . .	Government Central Press, Bombay.
36	Crops of Sind : their Geography and Statistics. Bombay Department of Agriculture Bulletin No. 150 of 1927. Price, Rs. 2-1.	Ditto .	Ditto.
37	Water-finder work in the Bombay Presidency. Bombay Department of Agriculture Bulletin No. 152 of 1928. Price, As. 8.	Rao Bahadur D. L. Sahasrabudhe.	Ditto.
38	Iron Mhotes for raising water. Bombay Department of Agriculture Leaflet No. 7 of 1927.	Issued by the Department of Agriculture, Bombay.	Aryabhushan Press, Poona City.
39	Agricultural Machinery and Agricultural Engineering. Bombay Department of Agriculture Leaflet No. 8 of 1927.	Ditto .	Ditto.

List of Agricultural Publications in India during 1927-28—contd.

No.	Title	Author	Where published
	GENERAL AGRICULTURE —*contd.*		
40	Manures for the tobacco crop in Gujarat. Bombay Department of Agriculture Leaflet No. 9 of 1927.	Issued by the Department of Agriculture, Bombay.	Aryabhushan Press, Poona City.
41	Tobacco as a crop in the Dharwar District. Bombay Department of Agriculture Leaflet No. 10 of 1927.	Ditto .	Ditto.
42	Pig killing to decrease damages to crops. Bombay Department of Agriculture Leaflet No. 12 of 1927.	Ditto .	Ditto.
43	Maize and *Tur* in the Gokak Canal Area. Bombay Department of Agriculture Leaflet No. 13 of 1927.	Ditto .	Ditto.
44	Cotton as a rotation crop in the Gokak Canal Area. Bombay Department of Agriculture Leaflet No. 15 of 1927.	Ditto .	Ditto.
45	Maize silage in the Gokak Canal Area. Bombay Department of Agriculture Leaflet No. 16 of 1927.	Ditto .	Ditto.
46	Poudrette as a valuable manure of sugarcane. Bombay Department of Agriculture Leaflet No. 17 of 1927.	Ditto .	Ditto.
47	Method of obtaining good *jowar* seed in the East Deccan. Bombay Department of Agriculture Leaflet No. 18 of 1927.	Ditto .	Ditto.
48	Sulphate of ammonia as a field manure for the rice crop. Bombay Department of Agriculture Leaflet No. 19 of 1927.	Ditto .	Ditto.
49	Annual Report of the Department of Agriculture, Bengal, 1926-27. Price, Rs. 6-2.	Issued by the Department of Agriculture, Bengal.	Bengal Secretariat Book Depot, Calcutta.
50	Rice. Bengal Department of Agriculture Leaflet No. 2 of 1927 (in English and Bengali).	R. S. Finlow, B. Sc., Director of Agriculture, Bengal.	Sreenath Press, Dacca.

List of Agricultural Publications in India during 1927-28—contd.

No.	Title	Author	Where published
	GENERAL AGRICULTURE —*contd.*		
51	Cultivation of Potatoes. Bengal Department of Agriculture Leaflet No. 3 of 1927.	R. S. Finlow, B. Sc., Director of Agriculture, Bengal.	Sreenath Press, Dacca.
52	The Cultivation of Sugarcane. Bengal Department of Agriculture Leaflet No. 4 of 1927.	Ditto .	Ditto.
53	The Cultivation of Country Tobacco (in English and Bengali). Bengal Department of Agriculture Leaflet No. 5 of 1927.	Ditto .	Ditto.
54	The Manufacture of *Gur* from Sugarcane. Bengal Department of Agriculture Leaflet No. 6 of 1927.	Ditto .	Ditto.
55	A Japanese Millet : a fodder crop. Bengal Department of Agriculture Leaflet No. 7 of 1927.	Ditto .	Ditto.
56	Monthly and Annual rainfall table in the Province of Bengal for 1927.	Issued by the Department of Agriculture, Bengal.	Ditto.
57	Season and Crop Report of Bengal for 1927-28.	Ditto .	Ditto.
58	Improvement of Bengal Cattle. Bengal Department of Agriculture Leaflet No. 1 of 1928.	Ditto .	Ditto.
59	Making a pit silage with unchaffed fodders. Bengal Department of Agriculture Leaflet No. 2 of 1928.	Ditto .	Ditto.
60	Comments on the return of expenditure on the Provincial and District Gardens in the Central Provinces and Berar for the year ending 31st March 1927. Price, As. 7.	F. J. Plymen, Director of Agriculture, Central Provinces.	Government Press, Nagpur.
61	The Cultivation of Groundnut. Central Provinces Department of Agriculture Bulletin No. 22. Price, As. 2.	W. Youngman and D. L. Janoria.	Ditto.
62	Report on the working of the Department of Agriculture of the Central Provinces for 1926-27. Price, Re. 1-7.	Director of Agriculture, Central Provinces.	Ditto.

List of Agricultural Publications in India during 1927-28—contd.

No.	Title	Author	Where published
	GENERAL AGRICULTURE —*contd.*		
63	Report on Demonstration work carried out in the Northern Circle, Central Provinces, together with Reports on Seed and Demonstration Farms for the year 1926-27. Price, Rs. 2-4.	J. H. Ritchie, M.Sc., Deputy Director of Agriculture, Northern Circle, L. N. Dubey, Offg. Extra Assistant Director, Jabbulpur, and Govind Prasad, Extra Assistant Director, Chhindwara.	Government Press, Nagpur.
64	Report on Demonstration work carried out in the Plateau Sub-Circle, Central Provinces, together with Reports on Seed and Demonstration Farms, Betul and Seoni, for 1926-27. Price, Re. 1-8.	E. A. H. Churchill, Assistant Director of Agriculture, Chhindwara, and Govind Prasad, Extra Assistant Director, Chhindwara.	Ditto.
65	Report on Demonstration work carried out in the Eastern Circle, Central Provinces, together with reports on the Seed and Demonstration Farms at Chandkhuri, Bilaspur and Drug, with that of Cattle Breeding Stations attached thereto for the year 1926-27. Price, Rs. 2-14.	T. L. Powar, Deputy Director of Agriculture, Eastern Circle, Raipur, N. G. Bhoot, Extra Assistant Director of Agriculture, Drug, and D. R. Mohrikar, Extra Assistant Director of Agriculture, Raipur.	Ditto.
66	Report on Demonstration work carried out in the Western Circle, Central Provinces, together with reports on the Seed and Demonstration Farm and Cattle Breeding Farms of that Circle for the year 1926-27, Vol. I. Price, Re. 1-13.	S. G. Mutkekar, Deputy Director of Agriculture, Western Circle, M. S. Barkar, Extra Assistant Director, Akola, and S. L. Mohammad, Extra Assistant Director, Amraoti.	Ditto.
67	Report on the District Demonstration work carried out in the Western Circle, Central Provinces, during the year 1926-27, Vol. II. Price, Re. 1-7.	S. L. Mohammad, Extra Assistant Director, Amraoti, and M. S. Barkar, Extra Assistant Director, Akola.	Ditto.
68	Annual Reports on Experimental Farm, Akola, and the Experimental Farm attached to the Agricultural College, Nagpur, for the year 1926-27. Price, Re. 1-10.	R. H. Hill, Offg. Economic Botanist for Cotton, C. P., and H. E. Annett, Offg. Principal, Agricultural College, Nagpur.	Ditto.

List of Agricultural Publications in India during 1927-28—contd.

No.	Title	Author	Where published
	GENERAL AGRICULTURE —*contd.*		
69	A Decennial Review of Biochemical Investigations on Soils carried out in the Central Provinces and Berar. Bulletin No. 23 of the Department of Agriculture, Central Provinces. Price, As. 5.	D. V. Bal, Bacteriological Assistant, Central Provinces.	Government Press, Nagpur.
70	Scientific feeding of Farm Animals. Bulletin 24 of the Department of Agriculture, Central Provinces. Price, As. 8.	R. G. Allan, Principal, Agricultural College, Nagpur.	Ditto.
71	Report on the Cattle Breeding Operations in the Central Provinces and Berar for the year 1926-27.	S. T. D. Wallace, Deputy Director in Charge, Animal Husbandry, Central Provinces.	Ditto.
72	Report on the Agricultural College, Nagpur, Chemical, Botanical, Mycological, Entomological Research, Agricultural Engineer's Section and Maharajbagh Menagerie, 1926-27. Price, Re. 1-5.	R. G. Allan, Principal, Agricultural College; A. R. Padmanabha Iyer, Agricultural Chemist; W. Youngman, Economic Botanist for Cotton, C.P., and D. N. Mahta, 2nd Economic Botanist, C. P.; J. F. Dastur, Mycologist to Government, C. P.; J. L. Khare, Assistant Entomologist; R. H. Hill, Officer in Charge of the office of Agricultural Engineer, C. P.; R. G. Allan, Principal, Agricultural College.	Ditto.
73	Annual Report of the Department of Agriculture, Bihar and Orissa, for 1926-27.	Issued by the Department of Agriculture, Bihar and Orissa.	Government Printing, Bihar and Orissa, Gulzarbagh.
74	Agricultural Statistics of Bihar and Orissa, 1926-27.	Ditto	Ditto.
75	Season and Crop Report of Bihar and Orissa, 1926-27. Price, Re. 2-4.	Ditto	Ditto.
76	Season and Crop Report of Bihar and Orissa, 1927-28.	Ditto.	Ditto.

List of Agricultural Publications in India during 1927-28—contd.

No.	Title	Author	Where published
	GENERAL AGRICULTURE —*contd.*		
77	Annual Report on the Administration of the Department of Agriculture, United Provinces, for the year ending 30th June, 1927.	Issued by the Department of Agriculture, United Provinces.	Government Press, Allahabad.
78	Report on the Agricultural Stations of Central Circle, Cawnpore, United Provinces, for the year ending 30th June, 1927.	Ditto .	Ditto.
79	Report on the Agricultural Stations of Western Circle, United Provinces, for the year ending 30th June, 1927.	Ditto .	Ditto.
80	Combined Report on the Experimental Stations in the Eastern Circle, United Provinces, for the year ending 31st May, 1927.	Ditto .	Ditto.
81	Report on the Agricultura Stations of the North-Eastern Circle, United Provinces, for the year ending 30th June, 1927.	Ditto .	Ditto.
82	Report on the Agricultural Stations in the Rohilkhand Circle, United Provinces, for the year ending 30th June, 1927.	Ditto .	Ditto.
83	Report on the Agricultural Stations in the Bundelkhand Circle, United Provinces, for the year ending 30th June, 1927.	Ditto .	Ditto.
84	Report on the Working and Administration of the United Provinces Government Gardens for the year ending 30th June, 1927.	Ditto .	Ditto.
85	Rudiments of Garden Designing	E. P. Griessen, Deputy Director of Gardens, Saharanpur, U. P.	Ditto.
86	Influence of Parks and Gardens and open space in civic development.	Ditto .	Ditto.

List of Agricultural Publications in India during 1927-28—contd.

No.	Title	Author	Where published
	GENERAL AGRICULTURE —*contd.*		
87	Cold Storage of Potatoes	P. K. Dey, Plant Pathologist to Government, Cawnpore, U. P.	Government Press, Allahabad.
88	Annual Report of the Department of Agriculture, Punjab, for 1926-27. Part I.	Issued by the Department of Agriculture, Punjab.	Government Printing, Punjab, Lahore.
89	Annual Report of the Lawrence Gardens, Lahore, for 1926-27.	Ditto	Ditto.
90	Prospectus of the Punjab Agricultural College, Lyallpur.	Ditto	Ditto.
91	Seasonal Notes for October, 1927.	Ditto	Ditto.
92	Guide to the Punjab Agricultural College and Research Institute, Lyallpur.	Ditto	Ditto.
93	A brief outline of the Agricultural conditions in the Punjab.	D. Milne, B.Sc., Director of Agriculture, Punjab.	Ditto.
94	List of Imperial Horse Shows to be held during 1928.	Issued by the Department of Agriculture, Punjab.	Ditto.
95	The Feeding of Adult Poultry. Punjab Department of Agriculture Leaflet No. 47.	Ditto	Ditto.
96	Poultry Houses and Runs. Punjab Department of Agriculture Leaflet No. 48.	Ditto	Ditto.
97	How to feed cows in milk. Punjab Department of Agriculture Leaflet No. 49.	Ditto	Ditto.
98	Poultry keeping for Punjab Farmers. Punjab Department of Agriculture Leaflet No. 52.	Ditto	Ditto.
99	How to begin poultry keeping. Punjab Department of Agriculture Leaflet No. 53.	Ditto	Ditto.
100	Hints on the sowing of *Toria*. Punjab Department of Agriculture Leaflet No. 54.	Ditto	Ditto.
101	Season and Crop Report of the Punjab, 1926-27.	Ditto	Ditto.

List of Agricultural Publications in India during 1927-28—contd.

No.	Title	Author	Where published
	GENERAL AGRICULTURE —*contd.*		
102	Tables of Agricultural Statistics of the Punjab, 1926-27.	Issued by the Department of Agriculture, Punjab.	Government Printing, Punjab, Lahore.
103	Seasonal Notes April (1928) issue.	Ditto .	Ditto.
104	Protecting of Trees from Sunburn. Punjab Department of Agriculture Leaflet No. 51.	Ditto .	Ditto.
105	Hatching chicks. Punjab Department of Agriculture Leaflet No. 56.	Ditto .	Ditto.
106	Instructions for working the Lyallpur Automatic Seed Drill. Punjab Department of Agriculture Leaflet No. 57.	Ditto .	Ditto.
107	Candying "*bers*" (*Jujubee*). Punjab Department of Agriculture Leaflet No. 58.	Ditto .	Ditto.
108	Feeding chicks. Punjab Department of Agriculture Leaflet No. 59.	Ditto .	Ditto.
109	Rearing chicks. Punjab Department of Agriculture Leaflet No. 60.	Ditto .	Ditto.
110	Report on the Operations of the Department of Agriculture, Burma, for the year ended 30th June 1927.	Issued by the Department of Agriculture, Burma.	Government Printing, Burma, Rangoon.
111	Report on the Mandalay Agricultural Station, Burma, for the year ended 30th June, 1927.	Ditto .	Ditto.
112	Annual Report of the Yawnghwe (South Shan States) Agricultural Station, Burma, for the year ended 30th June, 1927.	Ditto .	Ditto.
113	Annual Report of the Myaungmya Agricultural Station, Burma, for the year ended 30th June, 1927.	Ditto .	Ditto.
114	Annual Report of the Pyinmana Agricultural Station, Burma, for the year ended 30th June, 1927.	Ditto .	Ditto.

List of Agricultural Publications in India during 1927-28—contd.

No.	Title	Author	Where published
	GENERAL AGRICULTURE —*contd.*		
115	Annual Report of the Allanmyo Agricultural Station, Burma, for the year ended 30th June, 1927.	Issued by the Department of Agriculture, Burma.	Government Printing, Burma, Rangoon.
116	Report on the Mah'aing Agricultural Station, Burma, for the year ended 30th June, 1927.	Ditto	Ditto.
117	Report on the Padu Agricultural Station, Burma, for the year ended 30th June, 1927.	Ditto	Ditto.
118	Annual Report of the Agricultural College, Mandalay, for 1927.	Ditto	Ditto.
119	Annual Report of the Mudon Agricultural Station, Burma, for the year ended 30th June, 1927.	Ditto	Ditto.
120	Report on the Hmawbi Agricultural Station, Burma, for the year ended 30th June, 1927.	Ditto	Ditto.
121	Report on the Tatkon Agricultural Station, Burma, for the year ended 30th June, 1927.	Ditto	Ditto.
122	Report of the Agricultural Engineer, Burma, for the year ended 30th June, 1927.	Ditto	Ditto.
123	Report on the Pwinbyu Seed Farm, Burma, for the year ended 30th June, 1927.	Ditto	Ditto.
124	Annual Report of the Sa-aing (Thayetmyo District) Agricultural Station, Burma, for the year ended 30th June, 1927.	Ditto	Ditto.
125	Combined Report of Akyab Agricultural Station and Kyaukpyu Coconut Farm, Burma, for the year ended 30th June, 1927.	Ditto	Ditto.
126	Annual Report of the Mycologist, Burma, for the year ended 30th June, 1927.	Ditto	Ditto.

List of Agricultural Publications in India during 1927-28—contd.

No.	Title	Author	Where published
	GENERAL AGRICULTURE —*contd.*		
127	Annual Report of the Entomologist, Burma, for the year ended 30th June, 1927.	Issued by the Department of Agriculture, Burma.	Government Printing, Burma, Rangoon.
128	Annual Report of the Agricultural Chemist, Burma, for the year ended 30th June, 1927.	Ditto	Ditto.
129	Annual Report of the Economic Botanist, Burma, for the year ended 30th June, 1927.	Ditto	Ditto.
130	Season and Crop Report of Burma for the year ending 30th June, 1928. Price, Re. 1.	Commissioner of Settlements and Land Records, Burma.	Ditto.
131	Report of the Department of Agriculture, Assam, for the year ending 31st March, 1927.	Issued by the Department of Agriculture, Assam.	Assam Secretariat Printing Office, Shillong.
132	Fruit culture. Bulletin No. 1 of the Department of Agriculture, Assam (English and Khasi).	Ditto	Government Press, Shillong.
133	Cultivation of Pineapples. Leaflet No. 1 of 1928 of the Department of Agriculture, Assam.	Ditto	Ditto.
134	On Guinea Grass. Leaflet No. 2 of 1928 of the Department of Agriculture, Assam (Bengali and Assamese).	Ditto	Ditto.
135	On Vegetables. Leaflet No. 3 of 1928 of the Department of Agriculture, Assam (Assamese and Bengali).	Ditto	Ditto.
136	Report of the Agricultural Stations at Tarnab and Haripur in the North-West Frontier Province, 1926-27. Price, As. 13.	W. Robertson Brown, Agricultural Officer, North-West Frontier Province.	North-West Frontier Province Government Printing and Stationery Office, Peshawar.
137	Summary of Remarks on the Kharif Crop of the North-West Frontier Province for 1927-28. Price, As. 8.	Revenue Commissioner, North-West Frontier Province.	Ditto.
138	Report on the Season and Crops of the North-West Frontier Province for the year 1926-27. Price, Rs. 2-3.	Ditto	Ditto.

List of Agricultural Publications in India during 1927-28—contd.

No.	Title	Author	Where published
	GENERAL AGRICULTURE —*contd.*		
139	Report on the Administration of the Village Panchayats and Department of Agriculture in the Cochin State for the year 1926-27.	Superintendent of Agriculture and Panchayats, Trichur.	Government Press, Cochin, Ernakulam.
140	Annual Report of the Departments of Agriculture and Agricultural Engineering, Gwalior Government, 1926-27.	Issued by the Department of Agriculture, Gwalior.	Alijah Darbar Press, Lashkar.
141	Annual Report of the Agricultural Department, Mysore, for the year 1926-27.	Issued by the Department of Agriculture, Mysore.	Government Press, Bangalore.
142	Report on the working of the Amrit Mahal Department, Mysore, 1926-27.	Ditto .	Ditto.
143	Mysore Agricultural Calendar, 1928. Price, As. 2.	Ditto .	Ditto.
144	Report of work done in the Department of Sericulture in Mysore, during 1926-27.	Ditto .	Ditto.
145	Annual Report of the Department of Agriculture, Baroda State, for the year 1925-26. Price, Re. 1-6.	Issued by the Department of Agriculture, Baroda.	Baroda State Press, Baroda.
146	Annual Report of the Department of Agriculture and Fisheries, Government of Travancore, 1927.	Issued by the Director of Agriculture and Fisheries, Travancore.	Travancore State Press, Trivandrum.
147	*Quarterly Journal of the Indian Tea Association.* Price, As. 6 per copy.	Scientific Department of the Indian Tea Association, Calcutta.	Calcutta Orphan Press, Calcutta.
148	*Indian Scientific Agriculturist* (Monthly). Annual subscription, Rs. 4.	H. C. Sturgess, Editor, J. W. McKay, A.R.C.Sc., N.D.A., Consulting Editor.	Calcutta Chromotype Company, 52-53, Bow Bazar Street, Calcutta.
149	*Rural India* (Monthly). Single As. 6, Annual subscription, Rs. 3.	A. Swaminatha Ayyar .	President, Forest Panchayat Banking Union, Madras.
150	The *Journal of the Mysore Agricultural and Experimental Union* (Quarterly). Annual subscription, Rs. 3.	Mysore Agricultural and Experimental Union.	Bangalore Press, Bangalore.

List of Agricultural Publications in India during 1927-28—contd.

No.	Title	Author	Where published
	GENERAL AGRICULTURE —*concld.*		
151	The *Journal of the Madras Agricultural Students' Union* (Monthly). Annual subscription, Rs. 4; single copy As. 6.	Madras Agricultural Students' Union.	The Electric Printing Works, Coimbatore.
152	The *Planters' Chronicle* (Weekly)	Issued by the United Planters' Association of South India.	Diocesan Press, Post Box 455, Madras.
153	Annual Report of the Rubber Specialist, U. P. A. of South India, for 1927-28.	Ditto	"The Madras Mail" Press, Madras.
154	Administration Report of the Tea Scientific Officer, U. P. A. of South India, for 1927-28.	Ditto	Ditto.
155	The First issue of the Proceedings and Transactions of the Bengal Agricultural Intelligence Club, Dacca Farm (1923-24). Price for Members Rs. 2 and non-members Rs. 4.	Issued by the Secretary Bengal Agricultural Intelligence Club, Government Farm, Post Tejgaon, Dacca.	Narayan Machine Press, Dacca.
156	*Kisan.*—Agricultural Monthly Magazine started at Indore. Annual Subscription Rs. 3 or As. 5 per copy.	Sukhsampattirai Bhandari, M.R.A.S., Editor.	Gajanana Printing Works, Indore.
157	The *Nagpur Agricultural College Magazine* (Quarterly). Annual subscription, Rs. 3.	R. A. Ramayyar, and R. B. Ekbote, Editors.	Udyama Desha Sevak Press, Nagpur.
158	*Poona Agricultural College Magazine* (Quarterly). Annual subscription Rs. 2-8; single copy, As. 10.	College Magazine Committee, Poona.	Agricultural College, Poona.
159	The *Old Boys' Magazine, Agricultural College, Cawnpore* (Quarterly). Price, As. 8 per copy; Annual subscription, Rs. 2.	M. L. Saksena, L.Ag., Editor.	Cawnpore Printing Press.
160	The *Allahabad Farmer* (Quarterly). Single copy, As. 8; per year Rs. 2.	W. B. Hayes, E. W. Jeremy, J. N. Shivpuri.	The Mission Press, Allahabad.

List of Agricultural Publications in India during 1927-28—contd.

No.	Title	Author	Where published
	AGRICULTURAL CHEMISTRY.		
161	Experiments on the Feeding of Sorghum silage and concentrate to Scindi calves. Memoirs of the Department of Agriculture in India, Chemical Series, Vol. IX, No. 5. Price, As. 9 or 10*d*.	F. J. Warth, M.Sc., Physiological Chemist, Imperial Department of Agriculture and Shri Kant Misra.	Government of India Central Publication Branch, Calcutta.
162	Losses and Gains of Nitrogen in an Indian Soil studied in relation to the seasonal composition of well waters and the bearings of the results on the alleged deterioration of Soil Fertility. Memoirs of the Department of Agriculture in India, Chemical Series, Vol. IX, No. 6. Price Rs. 2 or 3*s*. 6*d*.	Harold E. Annett, D.Sc., F.I.C., M.S.E.A.C., A. R. Padmanabha Aiyer, B.A., and Ram Narayan Kayasth, M.Sc., B.Ag.	Ditto.
163	Some Digestibility Trials on Indian Feeding Stuffs: III. Some Punjab Hays. Memoirs of the Department of Agriculture in India, Chemical Series, Vol. IX, No. 7. Price As. 5 or 6*d*.	P. E. Lander, M.A., D.Sc., A.I.C., and Pandit Lal Chand Dharmani, L.Ag., B.Sc. (Ag.).	Ditto.
164	The Determination of the Electrical conductivity of the Aqueous extract of soil as a rapid means of detecting its probable fertility. Memoirs of the Department of Agriculture in India, Chemical Series, Vol. IX, No. 8. Price As. 4 or 6*d*.	Ashutosh Sen . .	Ditto.
165	Feeding Experiments at Karnal, 1925-26 and 1926-27. Memoirs of the Department of Agriculture in India, Chemical Series, Vol. X, No. 1. Price As. 8 or 10*d*.	F. J. Warth, M.Sc., and F. J. Gossip.	Ditto.
166	The Mechanical Analysis of Tropical Soils. Pusa Agricultural Research Institute Bulletin No. 172. Price As. 3 or 4*d*.	J. Charlton, M.Sc., F.I.C., Agricultural Chemist, Burma.	Ditto.
167	A comparative study of the methods of Preparation of the Soil for the Mechanical Analysis with a note on the Pipette Method. Pusa Agricultural Research Institute Bulletin No. 175. Price As. 4 or 5*d*.	Amarnath Puri, M.Sc., Ph.D., and B. M. Amin, B.A.	Ditto.

List of Agricultural Publications in India during 1927-28—contd.

No.	Title	Author	Where published
	BOTANY.		
168	The Kolamba Rice of the North Konkan and its Improvement by Selection. Memoirs of the Department of Agriculture in India, Botanical Series, Vol. XIV, No. 7. Price Re. 1-4 or 2*s*	R. K. Bhide, Crop Botanist to Government of Bombay, Poona, and S. G. Bhalerao, B.Ag., Superintendent, Rice Breeding Station, Karjat.	Government of India Central Publication Branch, Calcutta.
169	*Pennisetum typhoideum;* Studies on the *Bajri* crop: 1. The Morphology of *P. typhoideum.* Memoirs of the Department of Agriculture in India, Botanical Series, Vol. XIV, No. 8. Price As. 12 or 1*s.* 3*d.*	S. V. Godbole, M.Sc., B.Ag.	Ditto.
170	Studies in Khandesh Cotton, Part I. Memoirs of the Department of Agriculture in India, Botanical Series, Vol. XV, No. 1. Price Re. 1-4 or 2*s.* 3*d.*	S. H. Prayag, M.Ag., Cotton Breeder, Khandesh.	Ditto.
171	Colour Inheritance in Rice. Memoirs of the Department of Agriculture in India, Botanical Series, Vol. XV, No. 4. Price As. 6 or 8*d.*	S. K. Mitra, M.Sc., Ph.D., Economic Botanist to Government of Assam.	Ditto
172	The Indian Types of *Lathyrus sativus* L. (*khesari, lakh, lang, teora*). Memoirs of the Department of Agriculture in India, Botanical Series, Vol. XV, No. 2. Price Re. 1-8 or 2*s.* 6*d.*	Gabrielle L. C. Howard, M.A. and K. S. Abdur Rahaman Khan.	Ditto.
173	Studies on Rice in Sind, Part I. Memoirs of the Department of Agriculture in India, Botanical Series, Vol. XV, No. 6. Price Re. 1 or 1*s.* 9*d.*	K. I. Thadani, M.Sc., and H. P. Durga Dutt, B.Sc.	Ditto.
174	Studies in Gujarat Cottons, Part V. Memoirs of the Department of Agriculture in India, Botanical Series, Vol. XV, No. 7. Price As. 14 or 1*s.* 6*d.*	H. H. Mann, D.Sc., and M. L. Patel, M.Ag.	Ditto.
175	Studies in the shedding of Mango Flowers and Fruits, Part I. Memoirs of the Department of Agriculture in India, Botanical Series, Vol. XV, No. 8. Price As. 11 or 1*s.* 3*d.*	P. V. Wagle, M.Ag.	Ditto.

List of Agricultural Publications in India during 1927-28—contd.

No.	Title	Author	Where published
	BOTANY—*contd.*		
176	Studies in the Jowars of Gujarat: I. The Jowars of the Surat District. Memoirs of the Department of Agriculture in India, Botanical Series, Vol. XVI, No. 1. Price Re. 1-6 or 2*s* 3*d*.	M. L. Patel, M.Ag., and G. B. Patel, B.Ag.	Government of India Central Publication Branch, Calcutta.
177	The Improvement of Indian Wheat. (A brief summary of the investigations carried out at Pusa from 1905 to 1924 including an account of the new Pusa hybrids). Pusa Agricultural Research Institute Bulletin No. 171. Price As. 8 or 10*d*.	Albert Howard, C.I.E., M.A., Director of the Institute of Plant Industry, Indore, and Agricultural Adviser to States in Central India (formerly Imperial Economic Botanist, A. R. I., Pusa.)	Ditto.
178	A study of the Locular composition in Cambodia Cotton. Pusa Agricultural Research Institute Bulletin No. 178 Price As. 7 or 9*d*.	V. Ramanathan, L.Ag. .	Ditto.
	MYCOLOGY.		
179	Fruit-rot disease of cultivated Cucurbitaceae caused by *Pythium aphanidermatum* (Eds.) Fitz. Memoirs of the Department of Agriculture in India, Botanical Series, Vol. XV, No. 3. Price As. 6 or 8*d*.	M. Mitra, M.Sc., F.L.S., First Assistant to the Imperial Mycologist, and L. S. Subramanium, F.L.S., Assistant to the Imperial Mycologist.	Ditto.
180	*Asterina* spp. from India . .	Dr. Ruth Ryan, Rosary College, River Forest, Illinois, U. S. A.	Ditto.
	Meliola spp. from India and one from Malay. Memoirs of the Department of Agriculture in India, Botanical Series, Vol. XV. No 5. Price As. 4 or 5*d*.	Prof. F. L. Stevens, Urbana, Illinois, U.S.A.	Ditto.
181	Root-rot and Sclerotial Diseases of Wheat. Pusa Agricultural Research Institute Bulletin No. 177. Price As. 4 or 5*d*.	L. S. Subramanium, F.L.S.	Ditto.
182	Stem-rot of Berseem caused by *Rhizoctonia Solani* Kuhn. Pusa Agricultural Research Institute Bulletin No. 180. Price As. 8 or 9*d*.	Md. Taslim . . .	Ditto.

List of Agricultural Publications in India during 1927-28—contd.

No	Title	Author	Where published
	MICOLOGY—*contd.*		
183	The loose smut of wheat. Punjab Department of Agriculture Leaflet No. 46.	Issued by the Department of Agriculture, Punjab.	Government Printing, Punjab, Lahore.
184	Control of powdery mildew of grape. Bombay Department of Agriculture Leaflet No. 6 of 1927.	Issued by the Department of Agriculture, Bombay.	Yeravda Prison Press, Poona.
	ENTOMOLOGY		
185	Four New Indian Gall Midges	E. P. Felt, D.Sc., State Entomologist, New York.	
	The Citrus Psylla (*Diaphorina citri*, Kuw) (Psyllidae : Homoptera.) Memoirs of the Department of Agriculture in India. Entomological Series, Vol. X, Nos. 1 and 2 Price, Re. 1-2 or 2*s.*	Muhammad Afzal Husain, M.Sc., M.A., Offg. Imperial Entomologist, Pusa, and Dina Nath, L.Ag., B.Sc., Assistant, Entomological Section, Department of Agriculture, Punjab.	Government of India Central Publication Branch, Calcutta.
186	Some New Indian Miridæ (Capsidæ). Memoirs of the Department of Agriculture in India, Entomological Series, Vol. X, No. 4. Price As. 6 or 8*d.*	E. Ballard, B.A., F.E.S.	Ditto.
187	The use of Hydrocyanic Acid Gas for the Fumigation of American Cotton on Import into India. Experiments on its lethal power for the Mexican Boll-weevil (*Anthonomus grandis*) and for the grain weevil (*Silophilus oryzae*) ; on the extent to which it is absorbed by cotton and jute respectively and on a practical method for satisfactory fumigation on a large scale. Memoirs of the Department of Agriculture in India, Entomological Series, Vol. X, No. 5. Price Rs. 2 or 3*s.* 9*d.*	A. James Turner, M.A., B.Sc., Director, Technological Laboratory, Indian Central Cotton Committee, Bombay, and D. L. Sen, M Sc., Tech., M.Sc., A.I.C.	Ditto.
188	Studies on *Platyedra gossypiella*, Saunders (Pink Bollworm) in the Punjab. Memoirs of the Department of Agriculture in India, Entomological Series, Vol. X, No. 6. Price Re. 1-4 or 2*s.* 3*d.*	Sohan Singh Bindra, M.Sc.	Ditto.

List of Agricultural Publications in India during 1927-28—contd.

No.	Title	Author	Where published
	ENTOMOLOGY—*contd.*		
189	List of Publications on Indian Entomology, 1926. Pusa Agricultural Research Institute Bulletin No. 168. Price As. 10 or 1*s*.	Compiled by the Offg. Imperial Entomologist and the Imperial Entomologist.	Government of India Central Publication Branch, Calcutta.
190	List of Publications on Indian Entomology, 1927. Pusa Agricultural Research Institute Bulletin No. 184. Price As. 6 or 9*d*.	Compiled by the Imperial Entomologist, Pusa.	Ditto
191	Catalogue of Indian Insects. Part 13. Cicindelidae. Price, Rs. 2-8 or 4*s*. 6*d*.	Mercia Heynes-Wood, B.A., and Cedric Dover, F.E.S..	Ditto.
192	Palpicornia. Catalogue of Indian Insects, Part 14. Price Rs. 2-8 or 4*s*. 6*d*.	A. d'Orchymont, F.E.S.	Ditto.
193	Cecidomyidæ. Catalogue of Indian Insects, Part 15. Price As. 7 or 9*d*.	Ronald Senior-White, F.E.S., F.R.S.T.M. and H.	Ditto.
194	Cosmopterygidæ. Catalogue of Indian Insects, Part 16. Price As. 10 or 1*s*.	T. Bainbrigge Fletcher, R.N., F.L.S., F.E.S., F.Z.S.	Ditto.
195	Yponomentidæ. Catalogue of Indian Insects, Part 17. Price As. 8 or 10*d*.	Ditto	Ditto.
196	Injurious Field rats of Lower Sind and their extermination. Bombay Department of Agriculture Bulletin No. 138 of 1927. Price, As. 7-6.	P. V. Wagle and Khan Bahadur Gul Mohommed.	Yeravda Prison Press, Yeravda.
197	Grey Weevil of Cotton Seedlings Punjab Department of Agriculture Leaflet No 50.	Issued by the Department of Agriculture, Punjab, Lahore.	Government Printing, Punjab, Lahore.
198	The Rice Bug. Madras Department of Agriculture Leaflet No. 50.	Issued by the Department of Agriculture, Madras.	Government Press, Madras.
199	Control of mound building white ants. Bengal Department of Agriculture Leaflet No. 3 of 1928 (English and Bengali).	Issued by the Department of Agriculture, Bengal.	Sreenath Press, Dacca.

List of Agricultural Publications in India during 1927-28—contd.

No.	Title	Author	Where published.
	BACTERIOLOGY.		
200	A Bacterial Soft Rot of Garden Poppy. Memoirs of the Department of Agriculture in India, Bacteriological Series, Vol. II, No. 2. Price As. 5 or 6*d*.	C. S. Ram Ayyar, B.A.	Government of India, Central Publication Branch, Calcutta.
201	Seasonal Variations in the Germ Content of Milk at Pusa. Pusa Agricultural Research Institute Bulletin No. 170. Price As. 6 or 8*d*.	J. H. Walton, M.A.	Ditto.
202	A Method of Increasing the Manurial Value of Mahua cake. Pusa Agricultural Research Institute Bulletin No. 176. Price As. 4 or 6*d*.	N. D. Vyas, L.Ag.	Ditto.
203	Investigations in the Bacteriology of Silage, 1926-27. Pusa Agricultural Research Institute Bulletin No. 182. Price As. 5 or 6*d*.	J. H. Walton, M.A., M.Sc.	Ditto.
204	A Milk Fermenting Yeast. Pusa Agricultural Research Institute Bulletin No. 183. Price As. 5 or 6*d*.	C S. Ram Ayyar, B.A.	Ditto.
	VETERINARY.		
205	Some Diseases of Cattle in India. (A Handbook for Stock Owners) Revised, 1927.	J. T. Edwards, D.Sc., (Lond), M.R.C.V.S., Director, Imperial Institute of Veterinary Research, Muktesar.	Ditto.
206	Studies in Bovine Lymphangitis. Memoirs of the Department of Agriculture in India, Veterinary Series, Vol. IV, No. 2. Price Re. 1-3 or 2*s*.	V. Krishnamurti Ayyar, I.V.S., Professor of Pathology and Bacteriology, Madras Veterinary College.	Ditto.
207	Trypanblue and certain dithioaniline derivatives: Their efficacy in the treatment of Piroplasmosis and other affections in the Central Provinces. Memoirs of the Department of Agriculture in India, Veterinary Series, Vol. IV, No. 3 Price As. 3 or 4*d*.	Major R. F. Stirling, F.R.C.V.S., D.V.S.M., F.Z.S., I.V.S.	Ditto.

List of Agricultural Publications in India during 1927-28—contd.

No.	Title	Author	Where published
	VETERINARY—*contd.*		
208	Occurrence of Trichomonad Flagellates in the Blood Stream of Fowls. Pusa Agricultural Research Institute Bulletin No. 173. Price As. 3 or 4*d.*	Hugh Cooper, M.R.C.V.S., and Amar Nath Gulati, M.Sc., Imperial Institute of Veterinary Research, Muktesar.	Government of India Central Publication Branch, Calcutta.
209	Improvement and Care of Cattle in Bengal (Revised).	P. J. Kerr, I.V.S., and K. McLean, B.Sc.	Superintendent, Government Printing, Bengal.
210	Ditto (in Bengali) .	Rai Sahib S. C. Paul .	Ditto.
211	Annual Report of the Civil Veterinary Department, Burma, for the year ended 31st March, 1927.	Issued by the Civil Veterinary Department, Burma, Rangoon.	Government Printing, Rangoon.
212	List of Horse and Cattle Fairs and Shows in the Punjab and Punjab States for the year 1927-28.	Issued by the Department of Agriculture, Punjab, Lahore.	Government Printing, Punjab, Lahore.
213	Report of the work performed by the Camel Specialist, Sohawa, for the year 1926-27. Punjab Department Veterinary Bulletin No. 18.	Issued by the Department of Agriculture, Punjab.	Ditto.
214	Annual Report of the Punjab Veterinary College, Civil Veterinary Department, Punjab, and the Government Cattle Farm, Hissar, for the year 1926-27.	Ditto .	Ditto.
215	The Annual Administration Report of the Civil Veterinary Department, Ajmer-Merwara, for the year 1927-28.	Issued by the Superintendent, Civil Veterinary Department, Sind and Rajputana.	Government of India Central Publication Branch, Calcutta.
216	Annual Administration Report of the Civil Veterinary Department, North-West Frontier Province, for 1926-27.	Issued by the Civil Veterinary Department, North-West Frontier Province.	North-West Frontier Province Government Press, Peshawar.
217	The *Indian Veterinary Journal.* (Quarterly). Annual Subscription, Rs. 4 for members of All-India Veterinary Association and Students; Rs. 8 for others.	P. Srinivasa Rao, G.M.V.C., Editor.	Methodist Publishing House, Madras.
218	Surra	Issued by the Madras Department of Agriculture, Madras.	Government Press, Madras.

List of Agricultural Publications in India during 1927-28—concld.

No.	Title	Author	Where published
	VETERINARY—*concld.*		
219	Annual Administration Report of the Civil Veterinary Department, Madras, for 1926-27.	Veterinary Adviser to the Government of Madras.	Government Press, Madras.
220	Annual Administration Report of the Bombay Veterinary College, Bombay City and Harbour Veterinary Department and Civil Veterinary Department in the Bombay Presidency (including Sind) for 1926-27.	Issued by the Civil Veterinary Department, Bombay.	Government Central Press, Bombay.
221	Annual Report of the Civil Veterinary Department, Bihar and Orissa, for 1926-27.	Director, Civil Veterinary Department, Bihar and Orissa.	Government Printing, Bihar and Orissa.
222	Annual Report of the Civil Veterinary Department, United Provinces, for the year ending 31st March, 1927.	Issued by the Civil Veterinary Department, United Provinces.	Government Press, United Provinces, Allahabad.
223	Report of the Civil Veterinary Department of the Central Provinces and Berar during the year 1926-27.	Issued by the Civil Veterinary Department, Central Provinces and Berar.	Government Press, Central Provinces, Nagpur.
224	Report of the Civil Veterinary Department, Assam, for 1926-27.	Issued by the Civil Veterinary Department, Assam.	Assam Secretariat Printing Office, Shillong.

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Review of Agricultural Operations in India 1928-29



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PREFACE

The provincial reports upon which this Review is based deal with agricultural year 1928-29. In some Provinces the agricultural year coincides with the fiscal year ending in March : in others with the crop year ending in June. In some instances information is included in the provincial reports for later portions of the year 1929. These reports have appeared at various dates towards the end of 1929 and during 1930 : the last provincial report was received in February 1931.

In this Review an attempt has been made to include all information available up to the end of 1929, but the statistics quoted, with a few exceptions, necessarily relate to the *agricultural* year 1928-29.

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Review of Agricultural Operations in India 1928-29

CHAPTER I.

AGRICULTURAL CONDITIONS OF THE YEAR.

The monsoon rainfall of 1928 was somewhat erratic in its distribution both in respect to time and area. The spring of 1929 was marked by an unusually extensive and severe frost wave which affected much the whole of Northern and Central India. In MADRAS the season for the Presidency as a whole was fairly satisfactory though the South-west Monsoon was below the average in five districts and the North-East Monsoon erratic. Extensive damage was caused by floods in the area between Vizagapatam and Cocanada. In BOMBAY monsoon rainfall was above the average in North Gujarat, part of Khandesh and in the Konkan ; elsewhere in the Presidency it was on the whole below the normal. In SIND, monsoon rainfall was negligible. The winter rains were, generally, above the average especially in Sind. The season was, on the whole, a good one but considerable damage was caused in Sind and the northern portion of the Presidency by frost at the end of January and early February. In the CENTRAL PROVINCES AND BERAR the monsoon was on the whole favourable despite some loss, and greater anxiety, caused by deficient rainfall in some districts in September. Considerable damage was caused by frost and hail in the Jubbulpore District and the loss was intensified by damage to the wheat crop by rust following on late winter rains. The season was generally favourable for *kharif* crops but much less so for *rabi* crops. In the UNITED PROVINCES the arrival of the monsoon was timely and the early period not unfavourable, but rainfall throughout August and September was markedly deficient and the shortage was only partly ameliorated by rainfall somewhat above the average in October and

a fairly favourable winter rainfall. The damage to *kharif* crops was serious and *rabi* crops were restricted in area and below the average in yield. To some extent the shortage of rainfall was made up for by largely increased irrigation from canals, the opening of the new Sarda canal in particular doing much to relieve the situation. Serious failures of the rice crop, however, occurred in the East of the Province. Frost in February caused considerable damage to wheat and other *rabi* crops, especially in the West of the Province. In the PUNJAB monsoon rainfall was below normal in most districts and the weather unusually hot and dry. Floods following temporary heavy rainfall in September caused considerable damage. Early winter rains improved the prospect of the *rabi* crop but frost in January caused considerable loss. A shortage of fodder occurred in a large portion of the Province, especially in the South-East, necessitating special relief measures. Despite a plentiful supply of water in the canals, crops on the whole were below the average. In BIHAR AND ORISSA the monsoon was on the whole favourable, though considerable anxiety and some damage to crops was caused by a prolonged " break " in August and September. The distribution of rainfall in North Bihar was most erratic, the districts of Darbhanga and Muzaffarpur suffered from floods and the neighbouring district of Saran from drought. In BENGAL the monsoon was favourable on the whole, despite defective rainfall in September ; the winter rains were in marked defect. As a result the season was good for winter rice, favourable for autumn crops and fair only for spring crops. In ASSAM the monsoon rainfall was above the average. Heavy rain in May delayed cultivation, and though conditions from June to September were favourable, excessive rainfall in October and November resulted in damage by floods to rice, jute, sugarcane and tea. In BURMA the monsoon commenced earlier than usual and the early rains were generally favourable. In the mid-monsoon period the rainfall was favourable in the greater part of Lower Burma, but poor in much of Upper Burma though excessive in the Shwebo District causing floods. The late rains were a failure throughout the greater part of the Province. Damage from drought was reported in Magwe and

Mandalay Divisions. Except in the Arakan Division, the season was a poor one for the rice crop in Lower Burma. In Upper Burma weather conditions were generally favourable to rice but fair only for dry crops.

Locusts.

A few instances of locust swarms ovipositing in different parts of the country were recorded in 1928, but it was not until the late summer of 1929 that it became apparent that the general locust plague which had affected North and East Africa, the Soudan and Palestine in the two preceding years had reached India. By the end of 1929 serious locust damage had occurred in the United Provinces, Punjab, North-West Frontier Province, Rajputana and Sind. Full details are not available as this visitation falls outside the period with which some provincial reports deal. It may however be mentioned that the locust attack of 1929 was followed by a fresh 'invasion' of mature flying swarms, from Baluchistan or beyond, in February 1930 and that the most severe visitation on record was experienced by the Western Districts of the United Provinces, by the Punjab and Punjab States.

Features of the year.

The report of the Royal Commission on Agriculture was published in June 1928, and many provincial reports refer to the stimulus to agricultural improvement and the re-awakening of public interest in rural development which were the immediate result. During the succeeding year all Governments were engaged on the examination of the Commission's recommendations and in a general stock-taking of the position of their Agricultural Departments. Many of the recommendations of the report were in accordance with existing policy and called for development along accepted lines: others called for more careful consideration. Many recommendations have been accepted in principle as a guide to future development or to be given effect to when financial conditions permit; on others very definite action has already been taken. In October 1928, the Government of India called an all-India Conference to consider some of the more general recommendations of the Royal

Commission ; the Conference was opened by His Excellency the Viceroy and subsequently met under the Chairmanship of the Hon'ble Khan Bahadur Sir Muhammad Habibullah, Member of the Viceroy's Council for Education, Health and Lands. It was attended by all Provincial Ministers of Agriculture, the Secretary to the Government of India, Secretaries to Local Governments, the Agricultural Adviser to the Government of India, Directors of Agriculture and Directors of the Civil Veterinary Departments of the various Provinces and the senior staff of the Imperial Institute of Agricultural Research. In opening the proceedings, His Excellency the Viceroy characterised the report of the Royal Commission as "the most complete and creative document affecting the welfare of the agricultural population in this country which has hitherto been published," and drew special attention to the emphasis laid by Lord Linlithgow and his colleagues on the value of combined activity in the several fields of administration which dealt with the amelioration of the agriculturists' lot. After emphasising the urgent importance of agricultural research and the immediate concern of the Government of India in its promotion, His Excellency expressed the willingness of his Government, subject to the approval of the Legislative Assembly to specific proposals, to set up an all-India Council of Agricultural Research and to finance its operations adequately. The form which the new organisation would take was for discussion by the Conference.

Many questions of general interest were discussed and, though all Provinces reserved full liberty of action on matters of detail, a very general measure of agreement was reached on numerous issues. At the Conference the Hon'ble Chairman announced the Government of India's acceptance of the recommendation of the Royal Commission regarding the constitution of an all-India Agricultural Research Council and, at the close of the deliberations, Government's conclusions as to the constitution of the new body were stated. These proposals were subsequently approved by the Central Legislature and the Imperial Council of Agricultural Research was constituted by Government Resolution No. 826-Agri., dated the 23rd May, 1929.

As now constituted, the Governing Body consists of the Hon'ble Member of the Council of the Governor General for Education, Health and Lands, the Ministers for Agriculture in each Province, three representatives of the Central Legislature, two representatives of commerce, two representatives of the Advisory Board and a whole-time Vice-Chairman who is the principal administrative officer of the Council. The Advisory Board is widely representative of the Provincial Agricultural and Veterinary Departments, the Universities and special research institutes, and its constitution provides for additional members to represent special branches of agricultural science. The Hyderabad State is represented on the Council by a member of the Governing Body and two members of the Advisory Board, having made a substantial contribution to the Council's funds.

These two bodies together form the full Council which has been registered as a Society under the Registration of Societies Act, XXI of 1860, a step which gives it a considerable measure of financial independence. The objects of the Society as stated in the Memorandum of Association being—

(*a*) To aid, develop and co-ordinate agricultural and veterinary research in India by promoting scientific (including technological) research, instruction and experiments in the science, methods and practice of agriculture (including the marketing of agricultural produce) and by promoting veterinary research and instruction in veterinary science by the diffusion of useful information and by such other means as appear calculated to develop agricultural and veterinary research.

(*b*) To act as a clearing house of information not only in regard to research but also in regard to agricultural and veterinary matters generally.

(*c*) For the purposes of the Society to draw and accept and make and endorse, discount and negotiate Government of India and other promissory notes, bills of exchange, cheques or other negotiable instruments.

(*d*) To invest the funds of, or money entrusted to, the Society upon such securities or in such manner as may from time to time be determined by the Governing Body and from time to time to sell or transpose such investments.

(*e*) To purchase, take on lease, accept as a gift or otherwise acquire, any land or building, wherever situate in India, which may be necessary or convenient for the Society.

(*f*) To construct or alter any building which may be necessary for the Society.

(*g*) To sell, lease, exchange and otherwise transfer all or any portion of the properties of the Society.

(*h*) To establish and maintain a research and reference library in pursuance of the objects of the Society with reading and writing rooms and to furnish the same with books, reviews, magazines, newspapers and other publications.

(*i*) To do all other such things as the Society may consider necessary, incidental or conducive to the attainment of the above objects.

The inaugural meeting of the Council was held at Simla on the 21st June, 1929, when His Excellency the Viceroy, in opening the proceedings, referred to the fruitful field for co-operation between the Government of India and the Provinces which agricultural research offers, and to the means of linking the activities of the Research Council with those of Provincial Agricultural and Veterinary Departments which the presence of the Hon'ble Ministers for Agriculture on the Governing Body of the Research Council would afford. His Excellency also referred to the large measure of financial independence which the Council would possess in the administration of its research funds, to the fact that it was empowered to receive contributions in furtherance of its objects from other sources than the Government of India and to the prompt and generous offer of His Exalted Highness the Nizam to make a grant of two lakhs to the Council's research fund.

As recommended by the Royal Commission on Agriculture, the Research Council was provided with three whole-time members, *viz.*, a principal administrative officer as Vice-Chairman and two Expert Advisers, and with a Secretary. The Government of India appointed Dewan Bahadur Sir T. Vijayaraghavacharya, K.B.E., to be Vice-Chairman and Principal Administrative Officer of the Council, Mr. B. C. Burt, C. I. E., M. B. E., I. A. S., as Expert Adviser in Agriculture and Mr. M. S. A. Hydari, I. C. S., as Secretary. Since the end of the year Col. Olver, C. B., C. M. G., R. A. V. C., has been appointed Expert Adviser in Animal Husbandry.

The Imperial Council of Agricultural Research was registered as a Society under Act XXI of 1860 on the 16th July, 1929, and the first formal meetings of the Advisory Board, Governing Body and full Council were held at Pusa in December 1929. Amongst the Council's earliest activities were the establishment of a Sugar Committee, and a Committee on measures for the control of locusts. Action has already been taken on the interim reports of these Committees which are continuing their work. The Council has also decided to contribute to the Imperial Bureaux of Agricultural Research established as a result of the Imperial Agricultural Conference of 1927. The scheme provides for eight Bureaux dealing with special branches of agricultural science, and these have now all been established at the following places :—

The Imperial Bureau of	
(1) Soil Science. . . .	Rothamstead Experimental Station, Harpenden, Herts, England.
(2) Animal Nutrition . .	Rowett Research Institute, Bucksburn, Aberdeen, Scotland.
(3) Animal Health . . .	Veterinary Research Laboratory, Weybridge, Surrey, England.
(4) Animal Genetics . .	Animal Breeding Research Department, Edinburgh University, Scotland.
(5) Agricultural Parasitology .	Institute of Agricultural Parasitology, near St. Albans, England.
(6) Plant Genetics for Crops other than herbage plants .	Plant Breeding Institute, Cambridge University, England.

(7) Plant Genetics for herbage plants	Welsh Plant Breeding Station, Aberystwyth, Wales.
(8) Fruit Production . .	East Malling Research Station, East Malling, Kent, England.

India is represented on the Executive Council of the Bureaux by Dr. David Clouston, C. I. E., D. Sc., M. A., recently Agricultural Adviser to the Government of India.

The Government of India have provided the Imperial Council of Agricultural Research with an initial grant to its research fund of Rs. 25 lakhs, a recurring grant to the same fund of Rs. 5 lakhs per annum and have further provided the cost of the wholetime members and of the Council's Secretariat.

In other respects also the Government of India have given effect to the recommendations of the Royal Commission on Agriculture. Separate Directors have now been appointed for the Imperial Institute of Agricultural Research, Pusa, and the Imperial Institute of Veterinary Research, Muktesar, which were previously under the administrative control of the Agricultural Adviser to the Government of India, and the advisory functions previously performed by the Agricultural Adviser have been transferred to the whole-time members of the Imperial Council of Agricultural Research. By the rules of the Council Local Governments also have the right to obtain the advice of these officers on agricultural and veterinary matters. On appointment as Vice-Chairman, Imperial Council of Agricultural Research, Dewan Bahadur Sir T. Vijayaraghavacharya became *ex-officio* Agricultural Adviser to the Government of India until that post was abolished on the retirement of Dr. Clouston in October 1929 on the expiry of his leave. The Imperial Council of Agricultural Research has also assumed responsibility for the agricultural publications previously edited by the Agricultural Adviser and the Council of the Pusa Research Institute.

The Royal Commission recommended the formation of Provincial Agricultural Research Committees which would work in co-operation with the Imperial Council of Agricultural Research and report on any applications from within the Province for a grant

by the Research Council. It is clear, moreover, that such Committees would have a most important sphere of action in promoting and co-ordinating research directed to rural improvement within the Province. The Royal Commission's recommendation has now been accepted by all Provinces and Provincial Research Committees formed ; as anticipated by the Commission, the composition of the various Provincial Committees very considerably, depending *inter alia* on the nature of the other organisations such as Provincial Boards of Agriculture and Development Boards which previously existed.

In MADRAS a Provincial Agricultural Advisory Committee under the chairmanship of His Excellency the Governor was formed very shortly after the publication of the Royal Commission's report with the following principal functions :—

(*a*) To examine in detail the recommendations of the Commission which apply directly to the Madras Presidency and to formulate specific proposals where necessary ;

(*b*) to correlate as far as possible the activities of the various departments of Government concerned with schemes affecting the general uplift of the rural classes ; and to place schemes and suggestions before the Imperial Council of Agricultural Research. At present the Committee is constituted as follows :—

President.—His Excellency the Governor.

Members.—The Hon'ble the Minister for Development, the Hon'ble the Finance Member, the Secretary to Government, Development Department, the Director of Agriculture, the Director of Veterinary Services, the Registrar of Co-operative Societies, the Director of Industries, the Director of Fisheries, the Director of Public Instruction, the Director of Public Health, and four non-officials.

The Committee held four meetings during the year under report.

BOMBAY.—A Provincial Committee has since been formed.

BENGAL.—A Provincial Committee has since been formed.

UNITED PROVINCES.—The United Provinces Agricultural Research Committee was formed shortly after the inauguration of the Imperial Council of Agricultural Research. Of this Committee the

Hon'ble Minister for Agriculture is the Chairman and the Director of Agriculture the Vice-Chairman ; there are 10 members. The Committee which includes both departmental and University representatives is essentially a Committee of scientific experts able to advise the Local Government on research programmes, co-ordinate research work in various Provincial institutions and act as a link between the Imperial Council, the scientific officers of the Agricultural and Veterinary Departments and the research workers in the Universities. The Committee met during 1929 and examined two important research schemes for which grants have since been made by the Imperial Council of Agricultural Research.

PUNJAB.—A Provincial Research Council has been formed of 23 members under the Chairmanship of the Hon'ble Minister for Agriculture, the Financial Commissioner (Development) being the Vice-President ; the membership includes nine University representatives, ten departmental representatives, and four general non-official members.

BURMA.—Early in 1929, a Committee of four members presided over by the Hon'ble Minister was appointed to consider the recommendations of the Royal Commission.

BIHAR AND ORISSA.—A Provincial Agricultural Research Committee with the Hon'ble Minister for Agriculture as Chairman was appointed during 1929, shortly after the inauguration of the Imperial Council. The Committee includes eight departmental representatives, two University representatives and six un-official members, each representing one of the major divisions of the province. The Committee has examined two research schemes for submission to the Imperial Council of Agricultural Research for grants.

CENTRAL PROVINCES.—In order to provide a link with existing organisations, it has been decided to constitute a special Committee of the Provincial Board of Agriculture as the Provincial Agricultural Research Committee.

ASSAM.—A Provincial Committee was in process of formation at the close of the year.

The reports of provincial Departments of Agriculture pay tribute to the effect of the tours and report of the Royal Commission

on Agriculture in stimulating interest in agricultural development. In all Provinces the Commission's recommendations have been submitted to most careful examination both prior to the Agricultural Conference held at Simla in October 1928 and subsequently. As yet no Province has published a report of the action which has been taken on the Commission's recommendations but the annual reports of the Agricultural and Veterinary Departments and Government resolutions thereon indicate that many of the Commission's recommendations are acceptable ; the extent to which action on them will be taken in the near future depends both on the degree of development of the Provincial Agricultural and Veterinary Departments and on the state of provincial finances. Many of the recommendations were capable of immediate acceptance as being in accordance with accepted policy and in such cases Local Governments can proceed with the greatest confidence with their schemes of expansion and development. Several Provinces are working to definite expansion programmes and here the relative urgency for expansion in different sections of the department's work has been re-examined in the light of the Commission's conclusions. Other recommendations again have been accepted in principle but put aside, often regretfully, until finances have improved, until more urgent demands have been met, or until other developments make their consideration possible.

In Madras the recommendations of the Royal Commission on Agriculture on many matters affecting the organisation of the Department have been given effect to in a scheme of re-organisation which was sanctioned in May 1929 in the form of a ten-year development scheme. This scheme had for its principal object a better differentiation between research, administration and propaganda, the better organisation of propaganda and the more rapid development of research work on the more urgent agricultural problems of the Presidency. In their resolution on the report of the Agricultural Department for 1928-29, the Punjab Government state that most of the important recommendations of the Royal Commission had been " anticipated, accepted and adopted," but desire that the succeeding year's report should contain a summary of the action

which it is proposed to take on other recommendations. The Government of Bihar and Orissa have accepted a number of the recommendations of the Commission and have included them in schemes for the development of the department as finances permit. An officer has been placed on special duty to work out a scheme for an agricultural college.

In Bengal the scheme for an Agricultural Institute at Dacca which would work in close collaboration with the Dacca University is still held up by financial stringency but an attempt is being made meanwhile to start at an early date the Engineering, Dairy and Animal Husbandry Sections. The newly appointed Agricultural Engineer has started work on lift irrigation problems and on the improvement of sugarcane mills, and the new workshops which will form part of the Agricultural Institute have been erected.

CHAPTER II.

ECONOMIC WORK ON CROPS.

In no other branch of agricultural improvement has the success of the Agricultural Departments in India been so marked as in the replacement of bad seed by good, of bad or indifferent varieties by new ones of proved merit and of mixtures of unknown composition by pedigree strains. The reason is not that crop improvement is easy—indeed from the experimental point of view it often presents greater difficulties than improvements in manuring or cultivation—but no other improvement is so easily demonstrated or so readily accepted by the average agriculturist. The ascertained area under improved varieties of crops in 1928-29 was over 12 million acres, an increase of about 23 per cent. on 1927-28. The figures for the most important crops are shown below :—

Province	Total	Rice	Cotton	Wheat	Jute	Sugar-cane	Other crops
Madras . .	..	215,931	425,468	..	..	9,790	172,572 (Millets 15,000, Potatoes 9,150)
Bombay . .	..	17,405	1,036,873	29,684	..	2,513	430,541 (Groundnut 427,765, Bajra 1,663, Maize 1,113)
Bengal . .	..	185,255	..	..	1,137,605	67,019	3,848 .. ..
United Provinces	2,100,100	..	215,000	1,390,000	..	281,000	214,000 (Kharif 136,000, Barley 30,000, Gram 48,000)
Punjab . .	..	..	1,524,470	2,099,530	..	83,318	.. .. ..
Burma . .	..	323,125	6,570	..	..	..	.. (Groundnuts 13,983, Gram 168,116)
Bihar and Orissa	..	20,251	..	5,198	Not known.	46,088*	3,382 (Groundnuts 2,607)
Central Provinces	1,304,258	181,696	627,671	269,907	..	..	224,984 (Juar 129,773, Others 20,187, Groundnuts 75,024)
Assam . .	..	12,562	..	..	6,060	3,244	.. (Potato 2,731)
North-West Frontier Province.	..	..	..	330,500	..	620	21,120 (Berseem 12,000, Fruits 3,100, Maize 6,020)
TOTAL .	..	956,225	3,836,052	4,124,819	1,143,665	493,592	.. .. ..

* Taking 25,000 for North Bihar—otherwise 41,794.

Indian States (so far as information available).

State	Total	Rice	Cotton	Wheat	Millets	Sugarcane	Other Crops
Mysore . . .	248,467	20,000	15,000	..	200,000	6,000	7,467
Hyderabad . .	..	..	94,500 (B)	..	..	..	..
Baroda . . .	14,560	250 (L)	12,750 (L)	60 (L)	..	..	..
			1,500 (A)				
			14,250				
Travancore . .	438	438	..	..	..	..	..
Gwalior (c) . .	7,887	..	2,800	1,900	913	5	871 (Gram 290)
			1,389				
			4,189				
Bhopal . . .	410	..	..	117	..	293	..
TOTAL .	..	20,088	127,939	..	..	..	..

(c) All calculated from seed issues. (L) Calculated from seed-supply.
(A) Calculated from seed issued of Surat 1027.
(B) 91,500 acres area under Gaorani *plus* 3,000 approximate area under Gadag I and Dharwar I.

Areas in acres under improved crop.

Crops.	IN BRITISH INDIA.			In Indian States (so far as known) 1928-29.	Total 1928-29.
	1923-24.	1927-28.	1928-29.		
Cotton	2,848,882	3,272,638	3,836,052	127,939	3,963,991
Wheat	1,398,885	3,517,552	4,124,829	2,086	4,126,905
Rice	603,603	953,286	956,225	20,688	976,913
Jute	210,262	989,105	1,143,665	..	1,143,665
Sugarcane . . .	50,604	281,307†	493,592	6,298	499,890
Groundnuts* . . .	..	..	519,379	7,467	526,846
Millets*	467,146	964,037	146,436	200,913	347,349
Gram*	..	..	216,116	290	216,406
Potatoes*	..	..	11,881	..	11,881
Other crops* . . .	..	..	361,465	581	362,046
TOTAL .	5,079,382	9,977,875†	11,809,630	366,262	12,175,892

* Not separately reported by some provinces. † Revised.

The areas so recorded are of necessity considerably below the limit for two reasons. In the first place, only by special enquiries

can the total area due to the natural spread of an improved crop be determined. It is comparatively simple to record the quantities of seed issued departmentally and to determine the area sown but the greater the success of a department in decentralising seed-supply and in enlisting unofficial co-operation, the greater its difficulties in ascertaining the results of its efforts. Secondly, early improved varieties are now being replaced by still better strains and in such cases only the areas under the new varieties are readily determinable though the old favourites are still grown on a large scale and may still be spreading. In permanently settled Provinces where even the total area under a crop cannot be ascertained with even approximate accuracy, the difficulty of ascertaining progress is even greater.

The recorded area under improved crops has advanced again, now being 11,809,630 acres in British India. On the basis of Rs. 12 per acre, the figure adopted in last year's report, this represents an additional return to the growers of over 14 crores of rupees per annum. That the average of Rs. 12 per acre is not unduly high is shown by the detailed figures given in certain provincial reports. For example, the Director of Agriculture of the United Provinces in the annual report shows that for that Province alone the additional income to the cultivator resulting from improved strains of crops is 493 lakhs or nearly 5 crores of rupees ; the report of the Director of Agriculture, Central Provinces, shows that in 1928-29 the increased outturn resulting from the use of improved seed on 1,304,258 acres (mainly cotton and cereals) was Rs. 11,227,730. The value of agricultural research does not now need to be demonstrated by calculations of this nature ; nor is it necessary to emphasise that once the agriculturist's confidence is won by the supply of improved seed, he is more ready to adopt other tested improvements in agricultural practice.

I. Rice.

This crop occupies on an average some 35 per cent. of the total cultivated area in India ; in Assam the percentage is nearly 80, in Burma 74 and in Bengal 70. Its importance as a food crop may

be gauged from the fact that the average rice crop exceeds 30 million tons as compared to about 9½ million tons for wheat. Both the area and yield are considerably affected by the character of the monsoon though the marginally-noted* portion of the rice area is irrigated. The area under rice in 1928-29 was 82,126,000 acres and the yield 31,684,000 tons as compared to 78,113,000 acres and 28,176,000 tons in 1927-28. Of the increase, Burma accounted for 355,658 acres and 45,000 tons. The yield on the whole was good except in parts of the United Provinces.

*Province	Percentage of total rice area
Bengal	6
Bihar and Orissa.	22
Burma	11
Madras	73
United Provinces.	10
Central Provinces.	15
Bombay	42
Punjab	78

In BENGAL, rice occupies on an average some 19 million acres, which is nearly a quarter of the total area under rice in India or 71 per cent. of the cropped area of the Province. The area in 1928-29 was 21,404,000 acres.

Plant-breeding work for the improvement of the paddies of the Province has been in progress for over 20 years, and the area under improved strains (185,000 acres) testifies to the success achieved but hardly represents the progress achieved by research work. Suitable varieties are now available for many of the distinct tracts and the number of areas so provided for is steadily increasing. Amongst the late or *aman* paddies, Dacca No. 1 (Indrasail) continues to be the most profitable whenever conditions are suitable, especially in Eastern and Northern Bengal ; in Western Bengal it is being replaced by Nagra 68, Dudsar, Jhingasail (in Bankura District) and Chinsurah No. 2 (a strain of Bhasamanik from Hooghli District) ; in trials at Chinsurah extending over five years the last variety has proved the best yielder and it possesses the additional advantage that the grain is of finer quality than either Dudsar or Indrasail. At Barisal three selected strains of Balam rice have proved superior to the local variety and are being multiplied for distribution. At Dacca, Chinsurah, Bankura and Suri, where the selection and testing of new strains of both *aus* and *aman* paddies is being continued, some early maturing selections show great promise.

The system of multiplying selected paddy varieties at small local seed farms has been further developed and there are now 220 such centres in operation. The Agricultural Chemist has continued his work on the hydrogen-ion concentration of the " puddle " of

paddy fields and the results confirm his earlier conclusions that on acid soils (such as those at Dacca) the application of lime in doses just sufficient to counteract acidity leads to considerably increased yields of both grain and straw. A similar result was obtained at Rajshahi by neutralizing an alkaline soil with superphosphate.

In MADRAS, rice occupies about 11 million acres or 13 per cent. of the Indian acreage. A special paddy-breeding station is maintained at Coimbatore under the Paddy Specialist, and there are now sub-stations at Aduturai, Maruteru and Pattambi, each under the charge of a gazetted assistant. These stations represent the main paddy tracts of the Province. As the result of several years' persistent work a number of improved strains suitable to the various tracts are now available and the area under improved varieties approximates to a quarter of a million acres, the most important strains being those issued from Coimbatore and Aduturai. Studies of the inheritance of characters in rice are being continued and work has been started on the histology of paddy ; a satisfactory technique has been devised for the preparation of sections suitable for photomicrography. Special attention is being devoted to a study of the root-system of rice and the causes of lodging, and attempts are being made to obtain by hybridisation strains combining resistance to the " blast " disease (caused by the fungus *Piricularia oryzae*) with other desirable qualities. Special attention has been given to the organisation of the supply of seed of improved varieties through the medium of Government and private seed farms and co-operative societies, and the demand for seed still exceeds the supply.

Green-leaf manuring is found to be the most satisfactory method of manuring rice fields and at Coimbatore in a year of scanty rainfall proved of special value enabling a crop of 2,800 lbs. per acre to be reaped. In the Second (Guntur) and Fifth (Tanjore and Trichinopoly) Circles, ammonium sulphate has been found profitable and has been used freely by ryots.

The average area under rice in BURMA is about 12 million acres or 14½ per cent. of the total Indian acreage. The area under improved varieties during the year under report was 323,125 acres,

the varieties mainly distributed being Ngasein 8, Ngasein 10, Leywezin B. 107 and C. 1926 ; these varieties are higher yielders and of better quality than the local rices which they have replaced. The trade continues to pay premia for the improved strains but the premium paid for Ngasein 10 by the large mills was reported to be inadequate. In Arakan, the rice trade have agreed upon a system of allowances and premia for quality with special reference to the absence of red grain. Improved strains of the Emata type of rice obtained at the Hmawbi Farm from a type grown in the Prome district were all valued by the trade as superior to the Ngasein types and were reported to closely approach the popular " Garden Siam " type. These are early maturing strains which are probably suitable to the Upper Delta. The Director of Agriculture points out that the recent fall in the price of Burma rice is not due, as has been alleged, to its inferiority; in point of fact no such deterioration has taken place but, on the contrary, the Department is steadily evolving superior strains suited to different localities. Burma rice is now meeting with much keener competition than formerly in all export markets, and such competition is by no means confined to lower-priced rices. If the export market for Burma rice is to be retained and consolidated, much greater attention to quality and to methods of grading, packing, and marketing is required as well as an intensification of the plantbreeding and other research work which the Agricultural Department is already conducting. Special attention has been given to the question of fertilizers for paddy, remarkably uniform results have been obtained by the use of soluble ammonium and phosphate manures of the Leunaphos, Ammophos and Diammonphos types, both under average rainfall conditions in Lower Burma and in the Mandalay Canal area. Some environmental studies with rice have given interesting preliminary results. Upper Burma varieties transferred to Hmawbi in Lower Burma consistently produced softer rices than when grown at Mandalay, but, on the other hand, Hmawbi varieties showed no deterioration when transferred to Mandalay.

The average area under rice in BIHAR AND ORISSA is about 14 million acres or 17·3 per cent. of the Indian acreage. Over a large

portion of the Province, the prosperity of the cultivator is largely dependent on the rice crop. Owing to very varying soil and climatic conditions, rice-growing in Bihar and Orissa presents a number of separate problems many of which demand local treatment. On all the farms of the Department the testing of strains of rice for suitability is an important item of work. The estimated area under improved varieties during the year under report was 20,249 acres. As a medium early rice Dahia has maintained its popularity in South Bihar as in a considerable portion of Chota Nagpur, and the area under this variety is steadily extending. The four types of Orissa rice known as Cuttack I, II, III and V, a group of strains with different ripening periods, have increased in popularity. In North-East Bihar, the Latisail rice of Assam continued to do well. A botanical survey of the rices of South-East Bihar has recently been started by the Economic Botanist at Sabour. As in other Provinces, successful results have been obtained with fertilizers of the Ammophos type, especially for transplanted rice in South Bihar. On many soils also ammonium sulphate has proved profitable. Green-manuring continued to be successful in Orissa.

The annual area under rice in ASSAM averages about 4½ million acres or 5·6 per cent. of the Indian crop. In the Surma Valley 18 departmental strains of rice were under demonstration, the more important being Indrasail, Latisail, Nagrasail and Murali. In the Assam valley five strains were demonstrated. In manurial experiments at the Titabar Farm equally good results were obtained from cowdung with additional potash and from a mixture of sodium nitrate, bonemeal and a potash salt; when the additional potash was omitted, lower yields were obtained.

The average area under rice in the BOMBAY Presidency is approximately 3,331,000 acres or 3·7 per cent. of the Indian crop. The area under improved varieties was 17,405 acres—mainly Kolamba strains from the Karjat Rice-breeding Station. At this station a new strain "No. 40" possessing a fine grain has recently been isolated, which it is hoped to substitute for the coarse varieties at present grown on high-lying fields. At the Larkana Experimental Station in Sind, some high-yielding rice strains have been evolved and

attention is now being paid to the possibilities of the later-maturing high quality rices which an ensured irrigation supply should soon render practicable.

The average area under rice in the UNITED PROVINCES is about 7 million acres or 8·8 per cent. of the total Indian acreage. A botanical survey and classification of the rices of the Province has recently been completed and published as a Memoir of the Imperial Department of Agriculture and a number of types obtained which will now be tested and multiplied. The Director emphasises the fact that the revenue returns from the new Sarda Canal will depend largely on the success of the Agricultural Department's efforts to replace the coarse broadcast rices of that tract by transplanted rices properly fertilised and cultivated. Reference is made elsewhere in this Review to the important operations for seed-supply rendered necessary by the partial fixture of the rice crop in the Eastern portion of the Province in 1928.

The average area under rice in the CENTRAL PROVINCES is about 6,171,000 acres mainly concentrated in two Divisions of the Province. The area under improved strains is now 181,696 acres, but the Director draws attention to the need of a great deal more detailed scientific work on the rices of the Province. At Jubbulpore the question of rotations for the double-cropped areas is now receiving special attention, the alternatives being early rice followed by wheat or late rice followed by pulses. In the Southern Circle it has been found that ammonium sulphate at the rate of 100 lbs. per acre is a profitable manure for rice and at present prices its use is likely to extend.

The average area under rice in the MYSORE STATE is 701,000 acres ; the area under improved varieties is now 20,000 acres, of which the most widely adopted is the strain G. E. B. 24, originally produced at the Madras Department's Paddy Station at Coimbatore, which continues to spread : other popular varieties are Chintamani, Sanna and Banku. During the year the Naggenhalli Experimental Farm was developed into a special paddy-breeding station under the immediate charge of an Assistant Economic Botanist. This measure will enable the Mysore rices to be thoroughly studied.

II. Wheat.

In area the wheat crop is second only to rice and is almost as important a food crop. The area sown during 1928-29 was 32,011,000 acres as compared to 32,193,000 acres in 1927-28. The estimated outturn was 8,507,000 tons as compared to 7,791,000 tons in the previous year. Though an improvement on the previous year, the yield was not satisfactory in several important wheat tracts due to a shortage of rainfall during the latter portion of the monsoon and damage by frost; as a result the total production of wheat in 1928-29 was about one million tons below the normal expectation for the area sown. As might be expected, the supply of wheat was insufficient for internal consumption and imports of Australian wheat continued. Fortunately the crop of 1929-30 is a bumper one being estimated at 10,362,000 tons from an area of 31,178,000 acres. Though better than 1927-28, 1928-29 was a poor year for wheat but the advantages of the Agricultural Department's improved varieties were more obvious than ever; indeed their success under unfavourable conditions stimulated the demand for seed.

Work on the improvement of Indian wheats at the Imperial Agricultural Research Institute, Pusa, has been continued. It will be seen from the provincial notes which follow that the older Pusa wheats are now established over very large areas in different parts of India and that the newer varieties, Pusa 52 and Pusa 80-5, show great promise, especially in North Bihar. Of new strains, Pusa 111, 112, 113 and 114 are now undergoing field trials at Pusa and in the Provinces; the first three are selections from natural crosses in Pusa 4, whilst Pusa 114 is a bearded variant extracted from the well-known Australian Wheat Federation; in preliminary yield trials, these wheats showed considerable promise. The fourth hybrid generation of crosses between Pusa 4 and Pusa 52 respectively with Federation were grown at Pusa and Karnal and a few late-maturing cultures at Taru (North-West Frontier Province). Some of the strains obtained have too long a growing period for North Bihar but may be of considerable value to North-West India.

The Pusa Botanical Section, with the co-operation of the Pusa and Karnal farms, supplied 1,168 maunds of pure seed of nine types

to Provincial Agricultural Departments for experimental purposes and as a basis for seed multiplication, and also to private growers in North Bihar—from the latter the Bihar and Orissa Department of Agriculture was able to obtain a valuable nucleus for its general seed distribution scheme.

The PUNJAB normally has about one-third of the total Indian wheat area and produces about 40 per cent. of the total crop. The area grown in 1928-29 was 9,968,970 acres, and that under improved varieties, so far as could be determined, was 2,099,530 acres as compared to 1,859,310 acres in the previous year. The area under Punjab 8A has now reached 1,751,605 acres, that under Punjab 11 declining to 251,770 acres ; other improved types accounted for 96,155 acres. The Cerealist at Lyallpur has 15 hybrid wheats under study (all hard, amber-grained, bearded wheats) which under conditions of intensive cultivation promise to yield better than Punjab 8A and to be less liable to lodging, but it is at present doubtful if they will equal 8A under normal conditions of cultivation. The older type, Punjab 9D, is considered to be of promise for irrigated tracts and for moisture-deficient areas though, owing to its weak straw and poor tillering power, it is generally inferior to Punjab 8A.

Work is in progress on the effect of the nitrate and water-supply on the consistency of the Punjab wheats—present indications appear to be that abundance of water does not cause mottling provided that the nitrate supply is adequate and lodging avoided.

The UNITED PROVINCES has normally some 22½ per cent. of the Indian wheat area and produces about one-third of the total crop. The area sown in 1928-29 was 7,141,000 acres, the estimated area under improved varieties being 1,390,000 acres. As has been the case for many years, the well-known Pusa varieties—Pusa 12 and Pusa 4—predominate, their value was clearly apparent in the two unfavourable years 1927-28 and 1928-29. Other successful varieties are Cawnpore 13, Muzaffarnagar and Pusa 52. The increasing extent to which improved wheats are grown with intensive cultivation, *e.g.*, in rotation with sugarcane and under tube-well irrigation, is of special interest.

Normally the area under wheat in the CENTRAL PROVINCES AND BERAR is about 11 per cent. of the total Indian area ; most of the wheat is grown without irrigation in the heavy black soil tracts. The area sown in 1928-29 was 3,371,000 acres, the area under improved varieties being 269,907 acres as compared to 195,172 acres in the previous year. The importance of the department's rust-resistant strains was again demonstrated for, though there was no general rust attack comparable with that of 1927-28, the period of frost in February 1929 was followed by a secondary rust attack and the value of the Muriya-Khapli crosses (*Sharbati* wheats) A. 112, A. 113 and A. 115 was again demonstrated. In the Seoni tract the Pissi type A. 068 continues to be popular. In the Southern and Eastern Circles, Pusa 100 wheat continues to do well and is in increasing demand. The plant-breeding work at present in progress is directed to the production of rust-resistant strains for the main wheat belt and of an early, bearded, high-yielding type for the plateau districts. A study of the root development of different types of wheat under different soil conditions has been started. Preliminary observations indicate a considerable difference between the roots of wheat plants grown under open cultivation and of those grown in embanked fields under the *haveli* system.

Pusa 12 wheat has proved exceedingly popular in Northern SIND, the area sown in 1928-29 being 21,100 acres in the four principal taluqas or 55 per cent. of the total wheat area. Of new strains under trial in Sind, two, *viz.*, C. Ph. 47 and A. T. 38, appear to be good yielders. It is realised that with the new irrigation facilities, which the Lloyd Barrage canals will provide shortly, Sind requires a strong wheat of high milling value—this requirement is being kept in view in the work now in progress.

Though Pusa 4 and Pusa 12 wheats have been grown successfully on a considerable scale in BIHAR AND ORISSA in the past and still persist, neither has proved exactly the right wheat for average conditions. Extended trials have shown that Pusa 52 is suitable for South Bihar and a large portion of North Bihar and the area under this variety is rapidly extending. Pusa 80-5 has also proved a valuable wheat in North-West Bihar where it is being extensively

tested. In South-East Bihar, at the Sabour Farm which may be considered as almost outside the main wheat tract, Pusa 52 wheat with tube-well irrigation following sugarcane yielded up to 30 maunds per acre and averaged 23 maunds per acre.

In the NORTH-WEST FRONTIER PROVINCE, a very large number of varieties of wheat from all parts of the world have been grown at the Tarnab Farm (Peshawar) during recent years, but Pusa 4 is still the standard wheat of the Province, 30 per cent. of the total wheat area now being under this variety. Federation is satisfactory on the best single-cropped lands, whilst a new Australian variety Bena has done very well in a set of yield trials in 1928-29 but is possibly a little late in ripening.

The GWALIOR STATE has on the average 4½ per cent. of the wheat area in India. The area sown in 1928-29 was 1,096,000 acres. The Agricultural Department distributed improved seed for about 1,900 acres, its operations being hampered by frost damage which reduced the supply of seed from co-operating seed-growers. Pusa 4 wheat is stated to be growing rapidly in popularity on account of its immunity from rust ; a new wheat G. C. 17 selected at the Pipandi Agricultural Laboratory is reported to be very promising.

III. Cotton.

During the year 1928-29 review the area of cotton in India rose to 27,053,000 acres from 24,761,000 acres in the previous year, but the damage done by the frost in January 1929 to the Broach, Dholleras and Punjab-American crops appeared to be so heavy that the estimated yield was put at only 5,811,000 bales of 400 lbs. as against 5,963,000 bales in 1927-28. The number of bales pressed in India during 1928-29, however, was 5,004,000 as compared with 4,644,000 during 1927-28. When allowance is made for the quantity consumed locally the estimated yield was rather low ; but for the frost, a six-million bale crop would have been produced. Heavy stocks of cotton in Bombay and the depression in the local mill industry were largely responsible for the comparative cheapness of Indian cotton during a large portion of the year. This, however, had the effect of increasing the consumption of Indian cotton in

foreign countries and the exports for the year ending August 31st, 1929, rose to 3,933,000 bales, an increase of 793,000 bales over the exports of the previous year.

The INDIAN CENTRAL COTTON COMMITTEE has now completed eight years since its inception as an advisory body and six years since its incorporation under the Indian Cotton Cess Act 1923. During these years the attention of the Committee has been largely concentrated on the improvement of cotton marketing including the prevention of malpractices, and the promotion of research for the improvement of cotton-growing. Several of these research schemes have now borne fruit, and the Committee recently decided that it should take a more active part than previously in bringing the results of scientific research within the reach of the cultivator so that the resulting improvements may be incorporated in the general agricultural practice of the country. A beginning has been made by the Committee offering financial assistance towards the establishment of better organisations for the bulk supply of cotton seed of new varieties of proved merit.

Cotton Transport Act. Under this Act six zones were protected in the Bombay Presidency in August 1923. The Act continued in force in all these six areas during the year under review. It was mentioned in last year's Review that, despite the assurances to the contrary which were made when the restrictions on the transport of cotton by road between the three protected areas in Gujerat were removed, the growing of the inferior Surat 1-A cotton in the Olpad Taluka by the Sonsek cotton-growers had continued. The Committee therefore requested the Government of Bombay to re-impose the restrictions on road transport but this has not yet been done. Recently, however, the Hon'ble Minister in charge of Agriculture convened a conference of all interests to discuss the question. The longer the present conditions are allowed to continue, the greater will be the loss incurred by the growers of pure 1027 A. L. F. cotton in the Surat zone. The Act continued to work satisfactorily in the three protected areas of the Southern Division of the Bombay Presidency. The establishment of check stations on the principal roads leading into the protected areas for the control of imports of

cotton by road into the areas was found satisfactory ; the Committee has recommended to the Government of Bombay to establish a few additional road-check stations to prevent the entry of Barsi and Sholapur cottons into the Kumpta-Dharwar area through the Indian States of the Southern Mahratta Country.

Progress has also been made with the Committee's proposal to constitute a protected zone in the Broach tract, the Baroda Government have intimated their willingness to co-operate with the Government of Bombay in this matter, and negotiations with the other Indian States affected are practically complete.

In 1925 the Cotton Transport Act was applied to three areas in the Madras Presidency, *viz.*, (1) the Tirupur-Cambodia area, (2) the Tinnevelly area and (3) the Northerns and Westerns area. In 1927, the Government of Madras, in deference to the wishes of the local trade, decided to combine the first two areas into a single area comprising the eleven civil districts of Chingleput, South Arcot, Chittoor, North Arcot, Salem, Coimbatore, Trichinopoly, Tanjore, Madura, Ramnad and Tinnevelly. The third area, *viz.*, the Northerns and Westerns area, remained unchanged. This new arrangement which came into effect from the 19th September, 1928, places no restriction whatever on the movement of cottonseed by rail, road or sea, or on the import of lint, *kapas* and waste by road. In effect, therefore, the Cotton Transport Act as applied to these areas prevents only the importation of lint, waste and *kapas* by rail and sea.

The Hyderabad State Cotton Transport and Cultivation Act, which came into force during the year, replaced the Cotton Transport Ordinance of October 1927. The area now notified under this Act is larger than the one notified under the Ordinance, and comprises practically the whole of the tract once famous for its long-stapled Bani cotton. This Act also gives to the State powers to prohibit the growing of any variety other than the approved one in any specified area.

In the Baroda State, the Chhota Udepur State and in the Rajpipla State, legislation on the lines of the Cotton Transport Act

continued to work satisfactorily. The Indore Cotton Transport Act to which reference was made last year was passed after the close of the year under report but has not yet come into operation. In view of the fact that Central India is the home of the valued Malwa cottons and will shortly become a centre for the dissemination of the improved types evolved at the Indore Institute of Plant Industry, any measure which will protect the cottons of these areas from mixing is of obvious importance.

Of the Oomra group of cottons the superior type is the one produced in the four districts of Berar and in the adjoining districts of the Central Provinces, but on account of the free import of inferior Khandesh and Central India cottons into this area, the Central Provinces and Berar cotton does not fetch the premium it should. For some time past, the Indian Central Cotton Committee has been pressing the Central Provinces Government to notify this area under the Cotton Transport Act. The Government has now adopted the recommendations of the Committee, and drafted in June last the necessary notification and rules constituting the districts of Buldana, Akola, Amraoti, Yeotmal, Wardha, Chanda, Nagpur, Chhindwara, Seoni and Bhandara into a single protected zone. These rules have since been passed by the Legislative Council.

Cotton Ginning and Pressing Factories Act. Four years have now passed since this Act came into force. During the year under review the Committee devoted considerable time and attention to a study of its operation in British India, and to encouraging the introduction of similar legislation in Indian States. One of the most important problems with which the Committee had to deal during the year was the confusion caused in the Bombay market by numerous cases of the rejection of tenders, under Section 14 of the Act, on the score that one or more bales in the unit tender of 100 bales were not marked in accordance with the law in force. It was represented to the Committee that considerable loss or hardship was caused to sellers of cotton, and that unless the prescribed system of marking bales was scrupulously carried out in the pressing factories, similar trouble might arise at any time in the

future when there was a falling market. As was pointed out in last year's Review, immediate relief was given to the trade by a temporary amendment to Rule 7 of the Indian Cotton Ginning and Pressing Factories Rules, 1925. Rule 7 has now been permanently revised and it is now legitimate for the prescribed marks to appear in decipherable English figures and letters on any part of the bale except on the end hessians. The East India Cotton Association has also amended its bye-laws and only the unmarked, or faultily marked, bales in a tender are now liable to rejection instead of the whole hundred-bale unit as formerly.

A satisfactory feature of the Act is that the co-operation of Indian States has been secured in steadily increasing measure. Over 40 Indian States have now put similar laws into force, thus doing much to increase the value of the statistics of cotton pressed as well as enabling the identity of the various Indian cottons to be better established. The Committee continued to bring to the attention of Provincial and Indian States' authorities all cases of irregularities reported to it, and, at its instance, the Government of India again drew the attention of Local Governments to the necessity of improving the administration of the Act. The Punjab Government have now under consideration a set of draft Rules regarding the weights and scales to be used in factories and the permissible errors in them. The permissible errors previously adopted in Madras have been found to be too narrow for a bulky article like cotton, and the Government of Madras have taken up the question of amending their rules and adopting the same standard of tolerances as are in force in Bombay.

Cotton Finance and Marketing Enquiries. Mention was made in last year's Review of the results of the investigations carried out by the Committee into the finance and marketing of cultivators' cotton. The reports issued by the Committee have attracted considerable attention, and created a general interest in this type of economic study, whilst the form and method of enquiry and the thoroughness of the investigations have been very favourably commented on both by the Royal Commission on Agriculture and in the public press. The Madras and the Central Provinces

Governments have arranged for the translation of appropriate reports into the local vernaculars.

Primary Cotton Markets. The results of the investigations mentioned above emphasised the need for regulated open markets where the seller could obtain a fair price for his produce. Considerable progress has been made in this direction during the year. The rules under the Bombay Cotton Markets Act reached final form for submission to the Legislative Council. The Holkar Darbar being satisfied with the results of the new regulated open cotton markets at Sanawad and Barwaha, opened two more such markets. The experimental market started last year at Parbhani in the Nizam's Dominions clearly demonstrated the immense possibilities of such markets ; encouraged by the results obtained there and following the recommendation of the Royal Commission on Agriculture, His Exalted Highness the Nizam's Government have now decided to introduce the necessary legislation for open markets for all agricultural produce. The Government of the Central Provinces have still under consideration the modification of the Rules under the Berar Cotton and Grain Markets Law to bring these into line with the recommendations of the Indian Central Cotton Committee.

Marketing of Improved Varieties of Cotton. Through the medium of the technological reports on Standard Indian cottons, and the note on the progress made in the introduction of improved varieties of cotton in India supplied for the Bombay Cotton Annual, the Committee continued to keep the cotton trade informed of developments in this direction in the various parts of India. It was not considered necessary to continue the practice of supplying type bales of improved varieties of cotton to the various Cotton Exchanges as in previous years. With a view to increasing the use of Indian cottons in Lancashire, and thus to benefit the Indian producer, by broadening the demand for Indian cottons, the Committee again urged the Liverpool Cotton Association to amend the " Empire and Miscellaneous Futures Contract " so as to provide an adequate hedge for superior Indian cottons. Through the courtesy of the East India Cotton Association, replicas of the East India Cotton Association standards for Punjab and

Punjab-American cottons were supplied to the Manchester Cotton Association.

Measures to Prevent the Introduction of the Mexican Boll-Weevil. Throughout the season Indian cotton was relatively cheap compared to American cotton, and as there was no shortage of Indian taple cotton, imports of American cotton fell to 10,942 bales compared with 67,531 bales in the previous year. All American cotton was fumigated with hydrocyanic acid gas before landing as in previous years.

Cotton Statistics. The Committee continued to compile and publish weekly statistics relating to the purchases, shipments and arrivals of American cotton. The monthly statements of Indian cotton consumed in British India and the Indian States and of loose cotton received in mills in the major cotton-growing Provinces were also issued regularly. As in previous years discrepancies in the cotton forecasts brought to light by the cotton press returns were brought to the notice of the Government officers concerned in order that the errors might be traced to their source and avoided in future.

Cotton Research. From the foregoing it will be seen that the Committee's efforts to secure an improvement of cotton marketing in India and the economic condition of the grower have met with considerable success. No less has been the attention paid by the Committee to the improvement of the quality and yield of Indian cotton by scientific research. At the outset of its work the Committee realised that a properly-equipped laboratory, where the fibre properties and the spinning qualities of the cottons evolved by the agricultural research workers could be determined at an early stage in the evolution of new strains, was indispensable. The Committee's Technological Laboratory, meant primarily to fulfil this function, was established in 1924 ; during the year 1928-29 the Laboratory tested 46 samples of cotton for agricultural officers. In addition, the usual annual tests on twenty-one Standard Indian cottons of the season's growth were also carried out. These tests are all related to one fundamental problem, *viz.*, the determination of the quality or intrinsic value of a cotton as distinct from its current

market value. The results of these tests are embodied in the "Technological Reports on Standard Indian Cottons, 1929." As in the previous year separate reports on individual standard cottons were issued earlier in the season for the benefit of the cotton trade. Some spinning tests conducted on mixtures of Punjab-American and *desi* cottons in varying proportions yielded very interesting results which, if confirmed by further tests, should prove of considerable value and lead to a method of determining the extent of mixture in a given sample. The Committee have recently considered means by which the utility of the Technological Laboratory to the cotton trade could be increased and has decided to widen the scope of its work by undertaking tests on cotton samples submitted bytrade associations. With the same object in view representatives of the cotton trade and the mill industry have been co-opted as additional members of the Technological Research Sub-Committee.

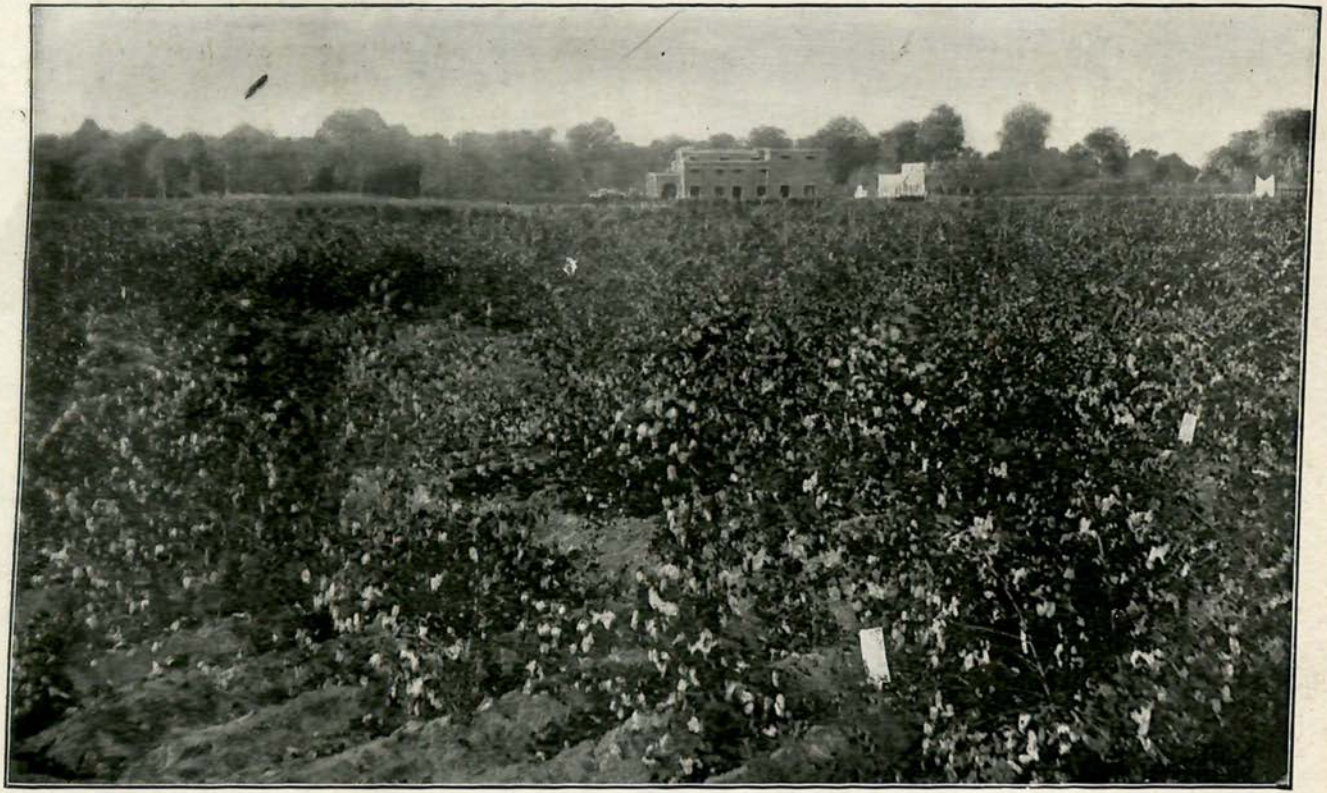
The Institute of Plant Industry, Indore, founded in 1924 as an agricultural research institute for work on cotton, which is financed partly by the Indian Central Cotton Committee and partly by a number of Indian States, continued its investigations of the fundamental problems affecting cotton in India as a whole, and of the problems peculiar to Central India in particular. In a recent book published by the Oxford University Press, entitled "The Application of Science to Crop Production", the Director describes the result so far achieved by the Institute. The careful study of the agricultural characters of the various Indian species and varieties of cotton, and the isolation of the unit species which make up the various varieties, now in progress at the Institute, should provide plant-breeders in India with material of great value. In the selection of an improved type of cotton for Central India some success has already been achieved; the isolation of an improved Malvi cotton of better staple than the local cotton, early-maturing and high-yielding, is in the words of the Director "only a question of a very short time". A small improvement in Malvi cotton has already been obtained by mass selection, and the Rural Development Department of the Holkar State has organised a seed distribution

scheme to meet the increasing demand from cultivators for the seed. On the low-lying areas of Central India where roseum cotton is now grown, it is expected that Dr. Youngman's Akola strain Verum 262 will prove suitable. Within the short period of its existence the Institute has made a study of the factors limiting the fertility of the black cotton soils of Central India, and Mr. Howard considers that (1) the perennial grass *kans* (*Saccharum spontaneum*), (2) water-logging, (3) the impermeability of the soil during the latter half of the monsoon and (4) low content of organic matter in the soil are primarily responsible for the low yield of cotton. The Institute has now devised simple, cheap and efficient methods for combating all of these except the third which the Director considers to be due to excessive development of soil colloids during the first half of the monsoon.

In addition to the Central Research Institute at Indore, the Committee financed during the year twelve research schemes in the important cotton tracts in India. Six of these schemes are connected with the selection and breeding of new varieties, while three deal with entomological, two with physiological and one with mycological problems. During the year under review, the Agricultural Research Sub-Committee made a thorough examination of all the Committee's schemes and decided to continue all of them except the Dharwar plant-breeding scheme.

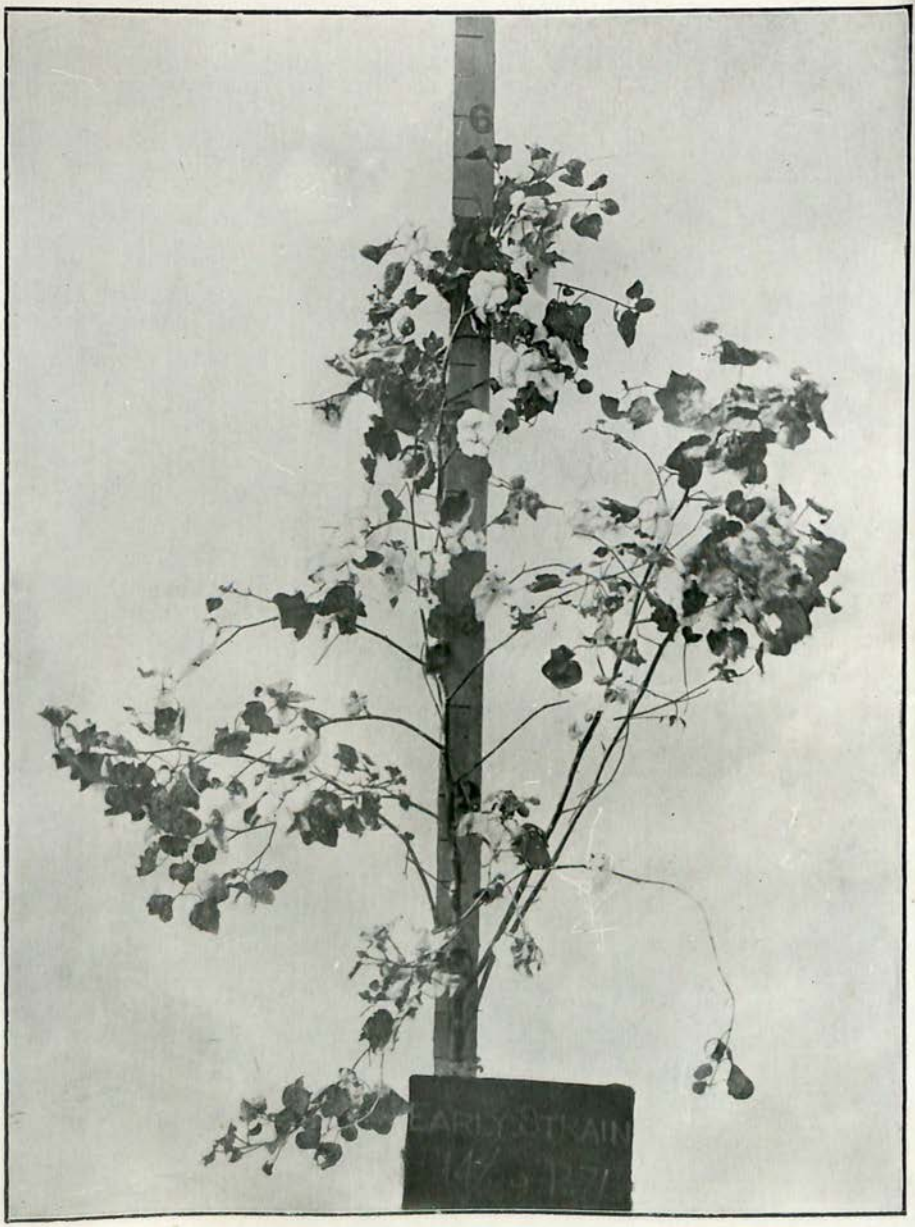
The Madras "Herbaceum" Cotton-breeding Scheme, which was started in 1923, aims at obtaining a suitable type of cotton for a tract having a light and precarious rainfall. In the Southern districts of the Madras Presidency there are about 800,000 acres of rain-fed cotton, mainly Karunganni and Uppam. In good years Karunganni is the better yielder, while in bad years the position is reversed, and as the season is a gamble the cultivator tries to meet the situation by growing a mixed crop. The object is to obtain a cotton possessing the hardiness of the Uppam type with lint quality not inferior to Karunganni. This scheme has now completed the first stage of work, and has entered the second in which five promising strains isolated from the local Uppam mixture have to be tested in the field, and the spinning capacities of each deter-

PLATE I.



General View of Pure-line Plots and the Cotton Research Laboratory, Lyallpur.

PLATE II.



"Early Strain" of Punjab-American Cotton.

mined. It is not expected that either of these strains will prove equal in quality to Karunganni, but by crossing the best strains with suitable long-staple types, a cotton possessing both the desirable qualities for this tract may be evolved; this will form the third stage of the work.

The Central Provinces and Berar Botanical Research Scheme at Nagpur under the Economic Botanist to Government, has now completed its sixth year of work. The success achieved by Dr. Youngman in the isolation of a wilt-resistant long-staple cotton, *viz.*, Verum 262, has been mentioned in previous reviews. During 1928-29 attention was concentrated on the distribution of the seed of this variety among the cultivators. The Local Government provided a sum of Rs. 50,000 for advances to cultivators who required financial help till the crop was sold. In the Khamgaon District the average yield of Verum on 218 acres of wilt-infested land, where other varieties produced a very uncertain crop, was 463 lbs. of *kapas* per acre, and the lint fetched a premium of Rs. 50 to Rs. 64 per khandi of 784 lbs. over Broach. In the season 1929-30 seed sufficient to sow about 35,000 acres was given out and approximately 6,500 bales of pure Verum were marketed with the assistance of the department. Under this scheme also the problem of boll-shedding and the formation of improperly ripened locks or "couries," which produce, on ginning, a brown mass of inferior lint which discolours the bulk, is now receiving attention, and is being investigated in relation to pollination and boll-opening. During the year the study of the inheritance of character in the "neglectum" cottons and the investigation into the causes of the low yield of cotton in Berar have also been continued.

The Punjab Botanical Research Scheme has now completed its fourth year of work. The primary object in view is the improvement of the cottons of the Punjab by modern method of plant breeding (Plate I). The work at Lyallpur has already yielded a strain of Punjab-American known provisionally as the "Early strain" (Plate II), which is equal to 289 F. in yield, superior to 4 F. in staple, and at the same time early maturing and less susceptible to the conditions which produce the periodical failure of the Punjab-

American crop. Another pure line, more promising than the" Early strain," is also under observation. The *desi* (oriental) types of Punjab cotton are also receiving attention and an improved strain of " Multani " cotton (*G. sanguineum*) has done well for three years in comparative field trials and has been taken up on a considerable scale at the British Cotton Growing Association's farm at Khanewal. Extensive records on the growth and development of the cotton plant at Lyallpur have been maintained, and step by step the causes of the periodic failures of the Punjab-American crop are being unravelled. Several publications from the Cotton Research Laboratory are in the press. It is sufficient to say here that it is now fairly clear that the periodical failures are due to a number of unfavourable factors and that the remedy lies partly in the adoption of new strains of cotton more adaptable to the somewhat severe environmental conditions which prevail in the Punjab and partly in improved methods of cultivation. The arrangement for maintaining the purity of the seed-supply of 4 F., 285 F., 289 F. and Mollisoni by large scale roguing on the farms of certain grantees continued as usual.

The object of the *Dharwar Cotton Breeding Scheme* was to work out the results of a cross between Gadagi (a selection from Dharwar-American cotton) and Sea-Island cotton which was made with the object of improving the staple of the Dharwar " Upland " type. Two strains have finally been retained, but neither come up to the desired standard. In the course of the work some useful information has been obtained on the possibilities of crosses of this type. The scheme has now been terminated and the material taken over by the Cotton-Breeder to the Bombay Department of Agriculture. At Dhulia, the Khandesh Cotton Breeding Research Scheme has as its object the production of a variety, or varieties for Khandesh with high yield, better staple and ginning percentage and wilt-resistance. Already a promising variety has been obtained by selection from material believed to have been originally obtained by a Bani Comilla cross. This cotton now known as " Banilla " cotton has been spun to 18s. to 20s. warp counts compared with 8s. to 10s. of the ordinary *Neglectum Roseum* type of cotton

grown in Khandesh. Another strain B XXI yielding 15 to 20 per cent. less than *N. R.* but spinning up to 30s. counts is also under observation.

The Hyderabad Botanical Research Scheme started only in May last. The most important part of the programme of work is the production of a higher ginning, more prolific and uniform type of good Gaorani strain suitable for the tract where at present the mixed Gaorani cotton is grown. Preliminary trials are also being made of a number of medium or long staple Upland American varieties to determine their suitability as an unirrigated crop in the Gaorani tract and as an irrigated crop in areas where canal irrigation is being made available.

Cotton wilt. Every year considerable damage is caused to the cotton crop in several parts of India by the disease known as wilt. The investigations financed by the Indian Central Cotton Committee at Dharwar were continued during the year under report, and further information as to the factors which determine the intensity of the disease, which is due to a *Fusarium*, was obtained ; in particular it was found that with relatively low temperatures (20° C. to 25° C.) the incidence of wilt was high ; at higher temperatures the attack was slight. One successful preventive measure is the use of resistant strains and several of these have been isolated, tested for resistance under severe conditions of artificial infection, and introduced into cultivation. But as there is some evidence that such resistance is largely local and may break down when the resistant strains are transferred to other areas, further study of the disease as well as the wider testing of resistant varieties is obviously needed.

The United Provinces Entomological Research Scheme was started in 1923 to determine the extent of damage caused by the pink boll-worm to the cotton crop in the United Provinces, to study its biology and to devise control measures. Observation, confirmed by experiments, showed that the damage to the crop from this pest ranged from 25 to 75 per cent. From a close study of the life-history of the moth, it was found that by far the most important source of infection of the new crop lay in the live larvæ

carried in " double " seeds, the chief danger being the stocks of seed stored for cattle food. Various methods of control were tried, and the most practical, efficient and economical one was found to be the heating of the seed to 60° C. (140° F.). In field experiments, it was found that very heavy re-infection by flight occurs up to a distance of four miles. From experiments conducted in an isolated tract near Hardwar during the last three seasons, convincing proof of the economic advantage resulting from heat-treatment of seed has been obtained. The confirmation of laboratory and small scale results on a field scale at first offered some difficulty as it was found that re-infection by flight was imported up to six miles. Fortunately an isolated block of some 1,200 acres of unirrigated cultivated land, which included 250-400 acres of cotton annually, was found in the Bijnor District, which was separated by natural barriers from other cotton cultivation to a distance of four miles on one side and eight to twelve miles on the others.

In 1926, 1927 and 1928, respectively, all cotton seed sown in this area was heat-treated ; pink boll-worm was absent until the end of the season (when light re-infection by flight occurred) and substantial increases in yield were recorded. In 1926 the yield in an unfavourable season was seven maunds per acre as compared to four maunds per acre outside the treated block, in 1927 again seven maunds as compared to 4½ and in 1928 (on 350 acres) 12 maunds per acre as compared to five maunds (irrigated) and three maunds (unirrigated) outside the block. In addition, the *kapas* from the treated area fetched a premium of 12 annas per maund due to its freedom from the stain and weak fibre associated with pink boll-worm damage. It is hoped in a future year to carry out a bigger scheme, in co-operation with the ginning industry, to take in the whole of Aligarh District and adjoining tahsils so as to provide an experimental area of over 4,000 square miles.

Meanwhile as a preliminary step, the Atrauli Tahsil of the Aligarh District, some 340 square miles in area and containing 20,000 acres of cotton, was selected for a field experiment for 1929 and the co-operation of cotton-growers, gin-owners and seed store proprietors secured. Though the area is too small for the full

advantages of seed treatment to be realised, since much of it would be re-infested by boll-worm from outside before the end of the season, the experience gained should prove of value when organisation on a larger area is attempted. In 1926, as a result of some preliminary work by one of the Committee's research scholars, a grant was sanctioned for an investigation of the influence of the climatic factors which govern the destruction of the pink boll-worm in the Punjab. In that province this pest is nearly as important in the South-Eastern Districts as in the United Provinces; in the Canal Colonies, on the other hand, it is of minor importance. The results so far obtained indicate that, as in the United Provinces, the principal source of infestation is larvæ carried in cotton seeds. In the Canal Colonies the intensity has never been so high as to call for control measures. It has also been demonstrated that during the period April-June one day's exposure of cotton seed to the sun is sufficient to destroy all pink boll-worm larvæ.

At Surat a scheme was started in 1923 to determine the damage done to cotton in Gujerat by the spotted boll-worms (*Earias fabia* and *Earias insulana*) and to devise remedial measures. Complete information on its life-history, egg-laying and other habits, parasites and other enemies and the amount of damage it does to cotton has now been obtained. The use of a poison dust and the mulching of the soil are being tried as remedial measures. In particular it has been established that the boll-worm is responsible for a great deal of "shedding" and that the main crop is in consequence abnormally late.

Under cotton physiology three investigations are being financed by the Committee. At Surat the causes of shedding of buds, flowers and bolls of the cotton plant in Gujerat and the measures to prevent them are being investigated. The results obtained so far show that *when cotton plants are protected from carrier boll-worm*, the shedding is due to competition between different parts of the plant for available plant food. Hence to increase that food, especially nitrogen, at the right time appears to be the remedy. Large-scale trials have been put down to confirm the tentative conclusions made from the small-scale tests. The Sakrand Physio-

logical Research Scheme has only just completed its first year of work. Problems connected with the water requirements, sowing date, and the general physiology of the cotton plant under perennial irrigation are being investigated here in anticipation of the change in agricultural conditions in Sind which will accompany the completion of the Lloyd Barrage canal system. Much useful information has been collected during the year on the growth and development of plants sown at different periods during the months of April to June.

Work in the Provinces and States. In the foregoing paragraphs the research work that is being carried out in the various Provinces and Indian States with the aid of grants from the Indian Central Cotton Committee has been discussed at some length. These research schemes supplement the normal work of the Provincial Departments of Agriculture, which deal not only with scientific research but also with the extension of new varieties and improved methods.

In the BOMBAY Presidency, which is the largest cotton producing province in India having in good years an area of over eight million acres of cotton distributed over four cotton tracts differing from each other in soil and climatic conditions, the problem of maintaining the purity of improved varieties is by no means an easy one. During the year under report pure seed of 1027 A. L. F., Gadag 1, Dharwar 1, Banilla, and 27 W. N., sufficient to sow a total estimated area of about 400,000 acres, was produced under direct departmental supervision. The area under improved varieties is now estimated at 1,036,873 acres.. By organised seed production and distribution, the quality of the improved varieties has been maintained. Proposals for the appointment of a Marketing Officer for the Presidency as recommended by the Royal Commission on Agriculture are now before the Government of Bombay.

The work on *herbaceum* cotton carried out in MADRAS during the year under review has already been referred to. The strain Co. 2 (previously known as Cambodia No. 440) continued to do well at Coimbatore. It has been found to be vigorous and disease-resistant and to yield 185 lbs. of *kapas* per acre more than the old

strains. With fair treatment this type is expected to yield on the average 1,000 lbs. of *kapas* per acre with a staple length of $1\frac{1}{8}''$; it is suitable for spinning 34s warp *counts*. The experiments on times of sowing reported last year were continued, and the results are distinctly in favour of the earlier sowing. An investigation into the water requirements of this crop is in progress—a matter of obvious importance as it is irrigated from wells. The Koilpatti Experiment Station has now been made a cotton-breeding sub-station. At Nandyal, work on the isolation and testing of pure strains of cotton has been continued; no strain of cotton superior to N. 14 has yet been obtained. As further study on the fungus *Vermicularia*, which causes the boll-rot and seedling blight of cotton, has revealed that the infection is carried in the seed-coat, control measures are now being investigatd. Steady progress has been made by the Department in the introduction of improved varieties of cotton, and it is satisfactory to note that the area under seed farms rose from 1,318 acres in 1924-25 to 6,948 acres in 1927-28 and 12,606 acres in 1928-29. About 970,000 pounds of seed were distributed from these farms alone and the area sown in 1928-29 was 260,000 acres. It is estimated that there are now at least 350,000 acres under improved strains of cotton evolved by the Department.

Reference has already been made to the botanical and research work on cotton carried out in the CENTRAL PROVINCES AND BERAR from funds provided by the Committee. In addition, a study of the effect of different cultural operations on the phosphatic content of black cotton soil is also in progress. The means by which infection takes place in the disease caused by the lint-staining fungus have also been determined. Under cotton entomology both the pink boll-worm and the spotted boll-worm are being investigated at Nagpur and Akola. At Akola where the pink boll-worm preponderates and appears much earlier than at Nagpur, it was ascertained that the larvæ of the last picking hibernate to a larger extent than those of the earlier pickings. Experiments on the hibernation of the pink boll-worm are in progress at Akola.

The work of the Cotton Research Botanist, PUNJAB, has been referred to above. Amongst other research activities may be mentioned an investigation into the cotton "white fly" and its relation to cotton crop failures, the red cotton bug (*Dysdercus cingulatus*) and a comprehensive series of field trials on rotations, manures, sowing time and waterings. The area under improved strains has risen to 1,524,470 acres and the Agricultural Department has further expanded its organisation for pure seed-supply, having issued during the year 31,381 maunds sufficient for some 300,000 acres, of which approximately two-third was Punjab-American 4 F. The mixing of Punjab-American cotton with *desi* cotton at the ginning factories continued to be a great problem as ever. While it is true that these mixed cottons find a market both in India and abroad, it is obvious that no spinner who knows his business will buy an unknown mixture unless he obtains it more cheaply than he could buy its components. The result of continued mixing has been to injure the reputation of Punjab-American cotton, reduce the price obtainable for unmixed cotton (except when sold under personal guarantees by a few growers who have been able to maintain a reputation for high grade cotton), and lower the price obtained by the average grower; many Indian mills requiring high quality staple cotton do not now buy Punjab-American. Fortunately the position is not irretrievable since, mainly owing to the Agricultural Departments' efforts, Punjab-American cotton is still grown unmixed. The Central Cotton Committee has recently offered to assist a scheme for the co-operative marketing of pure Punjab-American cotton, the object of which is to make unmixed cotton available to those consumers who are willing to pay a reasonable price for cotton of known quality.

UNITED PROVINCES. The important work on the control of pink boll-worm, which not only promises to materially increase the yield but revolutionise the quality of Bengals cotton if it can be fully developed, has already been referred to On the botanical side, the new cotton C. 402, which is suitable for spinning up to 22s counts and will fetch a substantial premium on local *desi*. was distributed on a considerable scale in Muttra and Bijnor,

The produce was readily taken up by local mills and a premium of Rs. 2-1 per maund (82·3 lbs.) of *kapas* paid to the growers. During the current year this seed was issued for about 1,000 acres in the new Sarda Canal area. The area under the heavy-yielding, high-ginning type of *desi* cotton A. 19 (which is suitable for spinning 6s to 8s counts) rose to 80,000 acres.

In *Burma*, Pwinbyu Wagale, an improved Wagale cotton, reached an area of 6,000 acres in the Myingyan Circle. In the same Circle the Department's re-selected strain C-19 gave very promising results wherever it was tried. In the West Central Circle, Cambodia was cultivated in the Thayetmyo and the Minbu Districts on small areas. In both the Circles a number of selected strains and hybrids, some of which appear to be promising, were kept under observation and studied.

The Agricultural Department of the BARODA STATE continued its policy of distributing the seed of 1027 A. L. F. in the Navsari District, a matter of great importance to the adjoining territory. Under advice from the Bombay Agricultural Department the distribution of Borach 9 cotton in the Baroda District was stopped. Banilla cotton was tried on the Amreli Farm and found to give a better yield than the local *Neglectum Roseum*.

The GWALIOR Department of Agriculture distributed seed for some 1,400 acres of cotton from their central farms and made a special free distribution of 650 maunds of cotton seed with the object of encouraging cotton cultivation in the Issagarh District. The provision of genuine Malvi seed for growing has received special attention, the department making arrangements for the purchase of Malvi *kapas* and for ginning under supervision.

The type Sannahatti No. 69, a pure line selection from the local type *G. herbaceum*, is becoming increasingly popular in the MYSORE STATE and special measures were taken to augment the supply of reliable seed. A large area under this crop was inspected by the Senior Assistant Botanist, *kapas* from selected fields was separately ginned under supervision at the Hebbal Farm and the resulting seed, which was sufficient for about 7,000 acres, issued as certified seed in sealed bags. The result was generally favourable

and during the current year double the above area under "certified" seed is expected. Co-operative societies for the ginning and marketing of this cotton are now being formed, and it is hoped to completely replace the ordinary cottons in the course of five years.

IV. Sugarcane.

During the year 1928-29 weather conditions were considered to be on the whole fair for the sugarcane crop. The area under sugarcane in the various Provinces of India and the Indian States was estimated at 2,727,000 acres as against 3,103,000 acres during the year 1927-28, or a decrease of 13 per cent. The production of *gur* and *jaggery*, both cane and palm, in India including Indian States, may be estimated at approximately 2,685,000 tons in 1928-29 as against 3,098,000 tons in the preceding year.

The quantity of sugar manufactured direct from cane in modern factories was 68,050 tons in 1928-29 as compared to 67,684 tons in 1927-28 and 62,941 tons in 1926-1927. The amount of refined sugar produced in modern factories by the refining of *gur* was 31,060 tons in 1928-29 as compared to 49,364 tons in 1927-28 and 58,087 tons in 1926-27. The production of crystalline sugar by the indigenous and improved *khandsari* processes is conventionally estimated at 50,000 tons annually, hence the total refined sugar produced in India in 1928-29 was 149,110 tons as compared to 167,048 tons in 1927-28 and 171,028 tons in 1926-27.

The imports of sugar in India during the fiscal year ending 31st March 1929 amounted to 868,800 tons, worth Rs. 15,86 lakhs, as against 725,800 tons, worth Rs. 14,50 lakhs in the preceding year (imported through the British Indian ports only). It is estimated that the consumption of factory-made sugar in India during 1928-29 amounted to 1,016,820 tons as against 951,500 tons in 1927-28. During the year prices of sugar were on the down grade as a result of over-production in the world and the failure of consumption to overtake production. Indian markets were also affected and declined with the arrival of heavy shipments of the new Java crop and later on by the cheap offerings of European beet sugar.

The Indian sugarcane growing industry has felt the effect of foreign competition keenly and even more so during the current agricultural year. In March 1928, it appeared that the fall in white sugar prices which had been steadily going on since June 1927, had been checked and prices recovered slightly to Rs. 11-1-3 per maund in June 1928; from that point the fall of prices was rapid and Rs. 9 per maund was reached. During 1929 prices remained low being Rs. 9 per maund in December 1929, and Rs. 8 per maund in February 1930. As a result of the enhanced duty, prices rose to Rs. 9-2 per maund in April 1930. Though there is no fixed relationship between the price of *gur* and sugar, the two commodities only replacing each other to a limited extent, the low prices for sugar forced down the price of *gur* to pre-war level; the average prices for *gur* in 1928-29 were, however, slightly better than in 1927-28 due to a smaller crop.

The effect of low prices on the grower has, however, been greatly mitigated by the effect of agricultural improvements, especially by the steady increase in the area under improved canes. Improved canes with pure juices have enabled several modern sugar factories to reach or exceed a recovery of 9½ tons of sugar per 100 tons of cane and have enabled the indigenous sugar factories (*Khandsari* process) to raise their sugar recovery substantially and to maintain their existence. More important still has been the increase in the yield of *gur* per acre attained by the average cultivator growing superior varieties which varies from 50 to over 100 per cent. The area under improved varieties in 1928-29 was known to be at least 493,592 acres or 11½ per cent. of the total area under sugarcane. The area under improved varieties in the four principal sugarcane-growing Provinces was not less than 477,400 acres, or 21½ per cent. of their sugarcane area. In the United Provinces, where the annual area under cane varies from about 1¼ to 1½ million acres, the area under improved varieties in 1928-29 was determined by a special enquiry to be 281,000 acres (as compared to 140,000 acres in the previous year). Even with the low prices ruling for *gur*, it is calculated that an additional income of 311½ lakhs has been realised by growers of improved varieties. In

the Punjab, the area under improved cane for 1928-29 was 25,803 acres and that planted for the season 1929-30 was 83,318 acres. In Bihar and Orissa, the area under Coimbatore canes for 1928-29 was reported to be 46,088 acres (since revised to 50,000), the area planted with these canes for 1929-30 being estimated at between 80,000 and 90,000 acres. In Bengal, the total area under improved canes was 67,019 acres.

In the UNITED PROVINCES, S. 48 is probably still the most important variety in the West of the Province and Co. 213 in the East, but Co. 290 is rapidly increasing in propularity in the irrigated tracts and may become the standard cane in Rohilkhand where a cane yielding pure juices and capable of high acreage yields under intensive cultivation is required.

In the PUNJAB, Co. 205 is still the favourite variety, especially where cane is grown without irrigation, but variety Co. 223 is more popular in irrigated areas but its susceptibility to *Pyrilla* attack appears to be a disadvantage and newer seedlings are being supplied for trial by the Imperial Sugarcane Expert. Co. 285 has given very promising results at Gurdaspur.

In BIHAR, Co. 205 has proved of value in low-lying and inferior lands but is an unpopular cane with sugar factories whilst its susceptibility to mosaic makes its general spread undesirable. The standard variety is Co. 213, but Co. 210 and Co. 214 are also grown on a considerable scale. Preliminary tests in North Darbhanga indicate that Co. 287 and Co. 290 may prove of value for the North Bihar white sugar belt.

In BENGAL, Co. 213 is rapidly replacing the previous introduction Tanna.

Work at the IMPERIAL SUGARCANE BREEDING STATION, COIMBATORE, has been continued and developed during the year. Several " Co." seedlings have proved to be a marked success in the Provinces and their cultivation is rapidly extending, but for many areas the best cane has not yet been found and there is need for intensification of the breeding programme. The improvements in technique (Plate III) made in recent years at Coimbatore have made it possible to produce a large number of seedlings of known



A Hybridization Shed at the Imperial Sugarcane Breeding Station, Coimbatore.

PLATE III.

parentage so that the possibilities of any promising combination can be fully explored. Two such crosses, *viz.*, Co. 213×214 and Co. 213×281 were made during the year and a large number of seedlings raised. The best way of carrying out the early testing of a large seedling population of this nature in Northern India is now being examined. Another method of work has been to produce a large number of seedlings by selfing a particular type which shows many desirable characteristics coupled with certain faults. In this way, by selfing Co. 205, the variety Co. 229 was obtained and from this in turn a large number of seedlings (over 15,000) have been raised, some of which appear to be desirable canes combining the hardiness of Co. 205 with higher quality. During the year special attention has been devoted to the morphological characters of cane in relation to resistance to diseases and pests. A systematic study of rind hardness was undertaken with the object of producing seedlings resistant to the attack of jackals and other small animals. Seedlings with narrow harsh leaves were selected for the Punjab in order to minimise the loss from attacks by *Pyrilla*. A general study of the leaves of sugarcane with the object of discovering adaptations that would discourage insect visitors was also started. Recent studies of the history of cane-breeding have emphasised the importance of wild *Saccharum* parents in several famous varieties of sugarcane, and Dr. Barber, the first Imperial Sugarcane Expert, was the first to use known crosses of *Saccharum officinarum* with *S. spontaneum* for the breeding of new varieties. A collection of *S. spontaneum* has been made at Coimbatore and nine distinct forms appear to exist; these have been studied in some detail during the year.

Rao Bahadur Venkatraman was appointed a member of the Standing Committee which the International Society of Sugarcane Technologists has appointed to deal with the nomenclature of sugarcane varieties—twenty-two descriptions of varieties were furnished from Coimbatore.

The breeding work on thick or "noble" canes for the more tropical parts of India was continued and a large number of seedlings, both hybrids and selfed, were raised for detailed examina-

tion. An extensive study was made of the flowering habits of the various canes, a point of practical importance in the devising of a programme for hybridisation. In the study of new seedlings, special attention was devoted to the root-system, as it is now known that the root characters largely determine the possibilities of a cane being a success in a particular area.

Studies on sugarcane pollen were continued. After considerable experiment it was found possible to keep sugarcane pollen alive for a period of 12 days by storage in an atmosphere of carbon dioxide at temperatures between 5° C. and 13° C. and relative humidity above 85 per cent. To successfully bridge the difference in flowering time between different varieties, it may be necessary to store pollen for more than a month.

At the PUSA RESEARCH INSTITUTE, the Agricultural Section continued the detailed testing of Co. seedling canes for suitability to North-East India. Co. 285 and Co. 295 may possibly prove suitable for the replacement of Co. 205 in low-lying areas in the sugar factory belt of North Bihar and estate tests are being arranged as also with the varieties Co. 290 and Co. 287 referred to above. A thorough test of Co. 281 is also being organised as, on account of its earliness and high sucrose content combined with other good characters, it should be of particular value to Bihar sugar factories. The Secretary, Sugar Bureau, has continued the organisation of estate scale trials and mill tests amongst the Bihar factories and by arrangement with the Bihar and Orissa Department of Agriculture supervised the sugarcane propaganda work in part of North Bihar.

SUGARCANE DISEASES. The study of the *mosaic disease of sugarcane* has occupied a large share of the time of the Mycological Section of the Pusa Research Institute during the year. The disease is widespread in India and has been found at practically every agricultural station visited. By roguing and sett selection and by special measures for the production and the distribution of disease-free setts for planting, it can be controlled. A special survey in North-West Bihar at 22 centres showed that the local cane—Hemja - was attcked with mosaic to an average of 12 per

cent. on 16,669 clumps examined, the infection ranging from 15·5 to 25·7 per cent. Co. 213 cane which is rapidly replacing Hemja was affected to an average of 1 per cent. only (range 0·3 to 3 per cent.). On a similar number of clumps Co. 205 was affected to the extent of 7 per cent. (range 4·5 to 13 per cent.).

At Pusa an experiment was again laid down to determine the effect of mosaic on the tonnage. An acre of Co. 213 planted with setts taken from canes, the leaves of which showed mosaic, yielded 387 maunds of stripped canes as compared to 407 maunds from the adjoining acre of cane from healthy setts. The yields are normal for unirrigated cane at Pusa and the difference is within the error of experiment. In a similar experiment with Co. 205, the yields were 572 and 548 maunds per acre—the difference again not being significant. Co. 205 is going out of cultivation around Pusa partly because of its susceptibility to mosaic but also because of its unsuitability as a factory cane. Attempts to eliminate mosaic from the cane by roguing proved a failure largely because a few canes show mosaic symptoms late whilst in others the symptoms disappear early. Co. 213, on the other hand, showed a 5 per cent. infection in 1925-26 which was brought down to 1 per cent. in 1926-27, 0·5 per cent. in 1927-28 and 0·3 per cent. in 1928-29, whilst Co. 210 which had 2½ per cent. in 1925-26 has only shown 0·01 to 0·02 per cent. since. Co. 214, Co. 248-Co. 270 and Co. 280 have remained free from mosaic throughout the four years whilst Co. 290 has shown a trace only. Sudden variations in the amount of mosaic have occurred in the varieties under detailed observation in the nursery during the monsoon of 1929, which in the absence of colonies of *Aphis maidis* suggests an unknown vector for the disease — a point which is receiving the attention of the Imperial Entomologist. It has been confirmed that mosaic disease can be transmitted from sugarcane to maize and *juar*: the disease was also found on Elephant grass (*Pennisetum purpureum*) at the Coimbatore Central Agricultural Station.

Top rot of sugarcane. During the last four years a disease of sugarcane which appears to be identical with the Pokkahboeng (*Fusarium*) disease of Java appeared in stray clumps in cane-

growers' fields in Bihar—it was first noticed in 1925 and the damage was at first thought to be due to insect attack by the top-shoot borer (*Scirpophaga xanthogastrella*). No damage has been caused so far but the disease appears to be slightly more common. Work on the disease is in progress.

The study and demonstration of IMPROVED METHODS OF CULTIVATION was further developed in several Provinces. Most progress has been made in the Rohilkhand Division of the United Provinces where the combination of improved varieties and intensive cultivation has been widely adopted on areas commanded by tube-wells and are now extending in the Sarda Canal area. Work at the Shahjahanpur Experiment Station has definitely shown that, provided irrigation water is available if needed to supplement rainfall in September, green-manuring with sann-hemp is the cheapest and most satisfactory method of maintaining soil fertility for an intensive system of agriculture which includes sugarcane as the principal crop in the rotation ; another essential to success is proper surface-drainage.

In Bihar and Orissa the Agricultural Department is able as the result of the work on the experimental farms to make definite recommendations on cane manuring. In North-West Bihar where sugarcane is grown without irrigation, the need for phosphate in addition to nitrogen was very definitely proved at the Sipaya farm and in some parts of South Bihar phosphate is a limiting factor on crop yields. The experimental work in progress is largely directed to the determination of the most generally profitable nitrogen-phosphate ratio.

In Bombay, especially in the Deccan canal area, the outstanding problem is to reduce the cost of cane production. During years of high prices both water and manure have been extravagantly used by many growers—in some cases causing permanent damage to the land. By the combination of improvements known as the Manjri system, the cost of cane production has been reduced from about twelve annas per maund to about eight. It is hoped that the cost of production can be reduced still further by the use of more suitable varieties. At Poona the economic application of nitro-

genous manures has been determined by several years' experiment to be about 150 lbs. of nitrogen per acre. Green manuring is commonly practised by the larger cane-growers and the use of ammonium sulphate has become standard practice in the Deccan canal area. On the Belapur Company's estate the seedling cane E. K. 28 has given the best results of the varieties tried and Co. 213 has proved a more economical cane than Pundia.

At the Anakapalle Experimental Station in Madras it was found that the local method of cultivation led to waste of irrigation water and reduced yields. Earlier planting following deep cultivation combined with reduced irrigation gave distinctly increased yields for all of the three varieties tried.

In Burma the area under cane is only about 20,000 acres annually and shows no sign of expansion despite the suitability of many parts of the province for this crop. One large estate at Sahmaw (Myitkina District) with an area of 7,000 acres has 1,500-2,000 acres under cane and is equipped with an up-to-date white sugar factory, producing at present 25 tons of sugar per day, the yield of commercial sugar on cane being somewhat over 10 per cent. The principal work on cane is carrid out at the Pyinmana agricultural station where variety testing is in progress and improved planting methods are under trial. It was ascertained that the cost of cane cultivation by the local method was Rs. 115 per acre and that the method of planting slanting setts in furrows instead of pit planting saved Rs. 9 per acre.

Throughout India the introduction of higher-yielding canes which more than double the weight of cane which the grower has to handle, has accentuated the need for improved crushing appliances in the *gur*-making tracts. Locally made three-roller bullock cane-mills are now a commonplace of the country side. The best three-roller bullock mills when well adjusted give a fairly satisfactory extraction but are too small in capacity, since the draught must be kept within the capacity of the average pair of bullocks. The general introduction of mechanical power for crushing would not only increase the efficiency of *gur*-making but, by reducing the strain on the available bullock power, facilitate a higher standard of

cultivation. Small power-driven cane mills are coming increasingly into use but there is a great need for better-designed mills than those at present on the market; experiments are in progress in several provinces. There is also considerable scope for increasing the efficiency of the *gur*-boiling process both in the direction of fuel economy and reduction in the amount of saccharine matter destroyed during boiling. Marked progress in this direction was made in Madras where 150 "Sindewahi" pattern furnaces were constructed during the year.

The constantly increasing import of sugar, the recent tendency for the Indian sugarcane area to contract and the fact that despite many improvements on the agricultural side, India is as far from being self-supporting in regard to sugar production as in 1920, is a matter of serious concern. In many parts of India, especially in the main sugarcane belt of Northern India, the development of a more intensive system of agriculture which will bring a more adequate return for their labour to a dense agricultural population is almost synonymous with the improvement and development of sugarcane cultivation. In these tracts any set-back to sugarcane growing means a check to agricultural progress. Hence the recent enhancement in the sugar import duties (in the budget of 1930-31) and the subsequent announcement that on the recommendation of the Imperial Council of Agricultural Research the Government of India had decided to refer to the Tariff Board the question of protecting the Indian sugarcane industry are of great importance to Indian agriculture.

V. Jute.

This commodity occupies an exceptional position in that it is an Indian monopoly which has at present no effective competitor in its own sphere and that jute cultivation is almost entirely confined to North-East India. Some 85 per cent. of the area is in the Bengal Presidency, the bulk of the remainder being in the adjoining portions of the provinces of Bihar and Orissa and Assam. The demand

for jute and jute manufactures varies with the course of the world's trade generally ; the yield and, to a considerable extent, the areas sown, are governed by climatic conditions so that fluctuations in price are inevitable.

The area under jute in 1928-29 was estimated at 3,144,000 acres and the outturn at 9,956,000 bales as compared to 3,374,000 acres and 10,460,000 bales in 1927-28. (The estimated area and yield for 1929-30 are 3,317,000 acres and 9,767,000 bales respectively.) The 1926-27 crop of 3,847,000 acres and 12,132,000 bales was the result of a spurt in sowings following a period of 'boom' prices and of an unusually favourable season. Exports of raw jute and manufactured jute for the fiscal year 1928-29 amounted to 1,809,000 tons valued at 89·2 crores of rupees as compared to 1,780,000 tons and 84·2 crores of rupees for the previous year. The area under the improved races of jute introduced by the BENGAL Department of Agriculture increased during the year to 1,143,665 acres. Of the improved strains of *Corchorus capsularis* D. 154 maintained its place as the heaviest yielder, the average yield at a number of farms working out at 22 maunds 19 seers per acre ; R. 89, a later selection, averaged 21 maunds 25 seers but gave higher yields than D. 154 at several centres. The previous year's experiments on the yield and quality of four standard varieties of jute grown in different localities were repeated, valuations of the fibre were carried out by the Indian Jute Mills Association and the Dundee Chamber of Commerce. The conclusion has now been reached that though quality is partly determined by the seed used, the most important factors are the conditions under which the jute is grown and retted. Since the most favourable conditions cannot be artificially reproduced, wide variation in the quality of jute grown at different localities is inevitable. The Agricultural Department's strains produce fibre similar in quality to the local varieties but are more efficient, the yield being on the average 25 per cent. above that of the local varieties.

It may be remarked, however, that but little work has been done on the factors which determine quality in jute and that

commercial valuations, though highly skilled, are still empirical. Until the factors determining spinning quality are studied in detail by the correlation of measurements of physical characters with the results of spinning tests, both the breeding of jute for quality and the determination of the effect of environment on commercial quality are almost impossible. Experiments on the percentage of fibre yielded by different varieties yielded interesting results and have afforded an explanation of the superior yield of strain D. 154 at most centres.

Manurial experiments with jute gave very promising results. Neutral ammonium sulphate gave satisfactory results at a number of centres—an expenditure of Rs. 8 per acre on manure producing increased yield of fibre ranging from 2 to 10½ maunds per acre worth say Rs. 16 to Rs. 84. Similar results were obtained at two centres with the *olitorius* variety. Both Ammophos and Diammonphos gave promising results at several centres. Experiments on the stage at which jute seed should be harvested have been in progress for several years and now indicate that with *capsularis* jute it is not necessary to wait until the seed is dead ripe but that with *olitorius* jute the germination of the seed is very low if harvested before it is absolutely ripe. It has also been shown that two-year old and three-year old jute seed is quite as good as new seed, provided that it has been properly stored in air-tight receptacles. Arrangements for the departmental supply of jute seed were continued. For the 1928 crop, 2,070 maunds were issued and for 1929, 2,550 maunds. The seed was supplied through the Government selling agent, the necessary germination tests, numbering some 2,500, being made by the Fibre Expert's Section.

In Bihar and Orissa, jute cultivation is mainly concentrated in the Purnea District of North-East Bihar, though not unimportant in several other districts. At the Purnea farm, Green Chinsurah (*olitorius*) jute has given consistently satisfactory results and a demand for seed has arisen. In Assam, the Dacca selection R. 85 (*capsularis*) and Chinsurah green (*olitorius*) continue to be the most productive varieties and a brisk trade in seed has sprung up. The

Agricultural Department supplied about 80 maunds of seed of these varieties.

VI. Other Fibres.

1. Hemp.

A new type of Roselle hemp (*Hibiscus Sabdariffa*) obtained by the Imperial Economic Botanist from Java in 1927 is of considerable intetest. Resembling *Hibiscus cannabinus* in its tall unbranched habit, and thus quite unlike the four Indian types of *Hibiscus Sabdariffa* described by Howard which are much branched, this " hemp " is likely to prove of economic value as it is immune to a disease which commonly affects *Hibiscus cannabinus* (*Patsan*) at Pusa. Specimens were identified at Kew, the Royal Botanic Gardens at Calcutta and in Java as *Hibiscus Sabdariffa* Linn.

2. Sann-hemp (*Crotalaria juncea*).

This is the most important of the Indian hemps, the normal area being some 500,000 acres. Exports of Indian hemp, mainly sann, during the last 10 years have varied from 13,000 to 37,000 tons and the value from 39 lakhs of rupees to 189 lakhs, but have commonly been in the neighbourhood of 25,000 tons valued at about 80 lakhs. There is a demand for good quality sann-hemp in London and recent experiments by the Imperial Institute, the results of which have been published by the Empire Marketing Board, show that it can be used successfully to replace Russian and Italian hemp for many purposes. Unfortunately, the supply of " dressed " hemp (*i.e.*, hemp which has been hackled before shipment) is inadequate and though the best Indian sann-hemp finds a ready market, much of it is unsuitable for the purposes required for the following reasons :—(1) The most serious complaint is the presence of an excessive amount of dust and dirt which often reaches 20 per cent. This is objected to by users not only because it involves the installation of special cleaning machinery but is prejudicial to the health

of the factory workers leading to objections from Factory Inspectors. It was originally assumed that this excessive dust was due to the fibre being retted in dirty water or mud and insufficiently washed, but there is good reason to believe that dirt is added during baling and that the cultivator is not always the person principally at fault. More recently the Indian Trade Commissioner has reported that small lumps of clay are often found at the end of the hanks and may possibly have been used to facilitate pressing.

(2) Buyers of the better qualities of hemp object to the twisting of the fibre into hanks and recommend that it should be packed flat for baling.

(3) Complaints are made of the presence of an undue amount of stick in the hemp from certain localities.

(4) Another complaint is that the hemp is insufficiently graded and that fibre of different quality and colour is included in the same bale—there is also a complaint that some of the fibre is immature or over-retted.

(5) It is also pointed out that for many purposes combed or heckled hemp is required.

(6) Some users object to the present dense baling, *viz.*, 40 cubic feet per ton as compared to 80 cubic feet per ton for the hemp of other countries.

It will be seen that many of these complaints are definitely connected with the handling of the hemp after it leaves the grower. The question has recently been taken up by the Imperial Council of Agricultural Research. Meanwhile, several Agricultural Departments are carrying out experiments to determine the effect of the time of retting on the quality of the fibre and the effect of harvesting at different periods of growth on the yield and quality of the fibre. In the United Provinces, an improved strain of sann-hemp has been produced and is now being tested and multiplied for distribution.

Sann-hemp is of economic importance as a rotation crop and is also the most important of all the green-manure crops. Since the

demand for sann-hemp seed is considerable, the question of the production of a marketable fibre from the straw after the seed has been harvested is of considerable importance.

VII. Tobacco.

This relatively small but valuable crop occupies about one million acres annually, the production being of the order of 1,000 million lbs. of dry leaf which approximates to 20 per cent. of the total quantity of tobacco produced in the world and some 90 per cent. of that produced in the British Empire ; the greater part of this is consumed in the country, though the export is by no means unimportant. In the tobacco growing areas the general system of cultivation is intensive and the crop employs a good deal of labour for a considerable portion of the year. The problem of tobacco improvement falls into three natural divisions :—

(*a*) The production of a good cigarette tobacco to meet the requirements of Indian factories and replace the present imports of Virginia leaf ; the production of high-grade pipe tobacco is another branch of this problem,

(*b*) The improvement of the Indian cigar tobaccos,

(*c*) The improvement of the stronger-flavoured Indian tobaccos which are used for *huqa* tobacco, chewing and snuff.

As the result of the work carried out at Pusa, the first problem is well on its way to solution. For cigarette-tobacco, flue-curing is essential and also a 'milder' leaf. It has been demonstrated that the well known American variety Adcock can be grown satisfactorily both in North Bihar and the Guntur District of Madras, provided that certain relatively simple changes in cultural methods are adopted. Curing barns for flue-curing are being profitably

worked in both areas. More important still, hybrids between the hardy and high-yielding Indian type, Pusa 28, and Adcock have now been fixed and tested and one of these No. 177 gave a leaf the colour of which when flue-cured was superior even to Adcock. Preliminary burning and smoking tests were carried out in collaboration with the India Leaf Tobacco Development Company and gave satisfactory results; this variety will be tested on a large scale during the coming season. Flue-curing experiments are in progress in Bengal and a barn is also being erected for the coming season at the Sa-aing Experimental Station in Burma. As regards high-grade pipe tobaccos, the American variety White Burley has been satisfactorily grown at Pusa and hybrids have been obtained. This side of the work is perhaps of less immediate application, for the market for Empire pipe tobaccos would seem to be well supplied at the moment but, as a corollary to the production of cigarette tobaccos, the economic possibilities are considerable.

(*b*) Work on Indian cigar tobaccos is in progress in Madras, Bengal and Burma and the next step appears to be the provision of expert assistance in the curing of the leaf. Experiments in cigar-making have been carried out at Rangpur for some years and have recently been transferred to Dacca. The Agricultural Chemist, Bengal, is engaged on a study of the nicotine content of a number of Indian tobaccos and the relation between this and the suitability of the variety for cigars, cigarettes and *huqa* tobacco.

The Indian cigar-making industry is already of considerable importance both for domestic consumption and export but at present much of the leaf for ' wrappers ' is imported and there is a demand for more good-quality tobacco suitable for cigar ' fillers'.

(*c*) The production of tobacco for domestic consumption as *huqa* tobacco, chewing tobacco and snuff is more widely spread. Here the problem is largely one of increasing the yield per acre by the use of selected strains and by better cultivation points to which the various Agricultural Departments concerned are devoting attention.

VIII. Oil-seeds.

The areas under the principal oil-seeds during 1928-29 as compared to the previous year, are shown in the following table :—

	1928-29		1927-28	
	Area in acres	Production in tons	Area in acres	Production in tons
Rape and mustard	7,025,000	908,000	5,931,000	846,000
Linseed	3,109,000	322,000	3,352,000	351,000
Sesamum	5,543,000	495,000	5,445,000	544,000
Groundnuts	6,351,000	3,211,000	5,244,000	2,571,000
Castor-seed	1,407,000	120,000	1,457,000	135,000
TOTAL .	23,435,000	5,056,000	21,429,000	4,447,000

As already noted, the area under cotton was 27,053,000 acres and from the yield of cotton (5,811,000 bales) the production of cotton seed may be calculated at approximately 2,100,000 tons. Exports of oil-seeds in 1928-29, including cotton and *mahua*, amounted to 1,328,410 tons valued at about Rs. 29,63 lakhs compared to 1,210,000 tons valued at Rs. 26,69 lakhs. Exports of the principal oil-seeds thus averaged only some 19 per cent. of the total production. In addition, 327,578 tons of oil-cake valued at Rs. 384 lakhs were exported.

The Royal Commission on Agriculture drew attention to the need for more research on this important group of crops. Oil-seed Specialists have recently been appointed in the Madras Presidency and in the Punjab.

Linseed. Work by the Imperial Economic Botanist at Pusa, the object of which is to produce a hybrid type combining the bold seed characteristic and high oil-content of the Central India types with the erect habit and shallow root-system required for successful cultivation in the Indo-Gangetic alluvium, was continued. From the F_4 generation of the original crosses 74 pure cultures have been selected and a number of these appear to possess the desired combination of characters.

In Bihar, Pusa type 121 (one of the earlier pure-line selections) has proved the best yielder for the last three years at Sabour, though its superiority over Pusa type 12 linseed was hardly significant. The type had previously proved successful at Sipaya. In the United Provinces a number of improved strains are under trial.

In the Punjab a collection of different local types has been made and is under study at Lyallpur. In the Central Provinces an effort is being made to find a high-yielding strain which is also resistant to rust. The type known as E. B. 3 has been found promising.

Mustard and rape. These crops are receiving some attention in Bihar, Bengal and Assam. As pointed out by the Howards several years ago, the introduction of new types of mustard and rape into general cultivation presents special difficulties, due to the persistence of viable seeds in the soil and would call for a higher degree of organisation of the seed supply than is generally practicable.

Sesamum. Work on the isolation of unit species of this crop has been continued at Pusa. A variety known as Huan-mi has been obtained at Allanmyo in Burma, which possesses the advantage that it can be sown at any time between August and October—a character which is likely to be of economic value in the dry zone.

Groundnuts. This leguminous oil-seed crop is of steadily growing importance in Madras, Bombay and the Central Provinces, and though recent low prices may occasion a partial check in the expansion of the area, its value as a rotation and cash crop is becoming more widely recognised. By far the largest area was in Madras which had 3,679,000 acres, but in the Khandesh Division of Bombay and in Berar its increasing use as a rotation crop for cotton is a welcome sign as this practice makes for the maintenance of a higher standard of soil fertility. In Bombay the area under this crop was 1,321,000 acres; groundnut cultivation is extending to the Deccan canal area: it is also of importance in Upper Gujarat and Dharwar. In the Chota Nagpur Division of Bihar and Orissa groundnut cultivation is extending slowly, despite difficulties in marketing and the damage caused by birds and wild animals.

In Madras the appointment of Oil-seeds Specialist was sanctioned during the year and has since been filled—this will enable work

on this crop to be further developed. At the small special experiment station at Palakuppam a promising beginning has been made with single plant selection : some useful preliminary information on the best time to harvest different varieties in order to secure the maximum oil-content has been collected.

Coconuts. In Madras, the successful demonstrations that on the West Coast coconuts can be grown under a system of dry farming, which were referred to in last year's Review, were continued and extended ; all of the 298 old demonstration plots were maintained and 73 new ones were added. The system is now widely adopted. Several thousands of acres of old gardens were improved and more than 10,000 acres planted. To meet the increasing demand for seedlings, special nurseries were established ; during the year 12,719 seedlings and 2,716 seed-nuts were sold, making a total for the past four years of 27,646 seedlings and 38,776 seed-nuts.

Experimental work on coconuts is undertaken on three experimental stations on the West Coast and includes seed selection, manurial trials, spacing and depth of planting experiments. A living collection of all the different varieties of coconuts in the world is being built up on these stations which will be of the greatest value in future. The new plantings of 1918 and 1919 gave some interesting results as to the date of yielding. Of 516 trees planted in 1919 on sandy loam, 84·3 per cent. had flowered in 1928 ; of those planted on laterite soil in the same year 63 per cent. only had flowered, whilst on a soil which was almost pure sand only 21 per cent. of trees planted in 1918 had flowered by 1928-29.

In Travancore State, experiments on coconuts have been carried out on the experimental farm at Karamarai for some 20 years. The manurial experiments show that the best results are obtained with a mixture of oil-cake, bone-meal, ashes and common salt. A further series of experiments with artificial manures (nitrate of potash, ammonium sulphate and superphosphate) show that the full effect of manurial treatment is not realised for 1½ to 2 years. Further manurial experiments on different types of soils were laid out in 1924 at four different centres, whilst varieties are under study at the coconut farm at Alleppey. During the year 16,800 selected seed-

nuts and 2,810 seedlings were sold. Work on the coconut leaf-roller was continued and the breeding of parasites for the control of the insect pest commenced. Four parasites, two of which attack the pest in the larval stage and two in the pupal stage, have been discovered and are under study: one of the latter promises to be of economic importance. The root disease of coconut is the most important of the coconut diseases in Travancore: it is now held by the Director of Agriculture that the principal cause is physiological, the disease is definitely infectious but is at its worst in those gardens where drainage and soil aeration are defective.

In *Burma* there is no large coconut planting industry though the total number of coconut palms is large; the ravages of the Rhinoceros beetle make the extension of this crop uncertain. Two experimental coconut plantations of 10 acres each are maintained by the Agricultural Department near Akyab and at Kyaukpyu respectively, the object of the latter being to encourage the extension of the crop in Arakan. At Akyab a series of manurial experiments has been laid out and in all the manured plots flowering began during the year but not in the unmanured block.

IX. Tea.

The total area under tea in India in 1928 was 773,023 acres as compared to 755,994 acres—the revised return for 1927. Of this area, 81 per cent. lies in Assam (Brahamputra and Surma Valleys) and in the adjoining districts of Northern Bengal—Darjeeling and Jalpaiguri. The area in Southern India was 127,100 acres as compared to 124,600 acres reported for 1927. The total area of tea plucked amounted to 705,700 acres as compared to 695,900 in the preceding year. The estimated production was 403,765,000 lbs. (of which 399,859,000 lbs. was black tea) compared to 390,920,000 lbs. in 1927. Exports of Indian tea by sea in the year 1928-29 amounted to 359,784,000 lbs. compared to 362,012,000 lbs. in 1927-28. Exports by land, as registered at selected railway stations adjacent to the land frontiers, amounted to 8,424,000 lbs. as compared to 8,892,000 lbs. in 1927-28; not all of this however is frontier trade proper. A system of estimating the actual

exports by land was introduced during the year by the Director General of Commercial Intelligence and Statistics in consultation with the Indian Tea Cess Commissioner, the estimate for 1928-29 being 5,041,000 lbs. The amount of tea available for consumption in India in 1928-29 was 57 million lbs. compared to 43 million lbs. in 1927-28 and an average of 46 million lbs. for the preceding five years.

The Scientific Department of the Indian Tea Association continued their investigation on the effects of manures, pruning and cultural operations on the yield, diseases and pests of the tea bush, on the effect of soil conditions on the growth of the tea plant and on the effect of different methods of treatment of the leaf on the quality of the tea. The previous year's conclusions on the question of liming and soil acidity were amply confirmed. With rare exceptions all soils of very low acidity grow very poor tea and when good tea is found growing on soil which is practically neutral at the surface, the sub-soil is normally acid : no cases of good tea growing on soils of low acidity persisting to any depth have been recorded. Benefit from liming has been obtained only in cases where high soil acidity caused failure of green crops and even then the application of lime should be the minimum necessary. Valuable work on the Assam tea soils generally is in progress to which further reference is made in Chapter III.

Experiments on the effect of manures on the caffeine and tannin contents of the tea leaf showed that neither large nor small applications of nitrogen, phosphate and potash had any appreciable effect on the caffeine content. Large doses of manure appeared to lead to a slight decrease in the tannin content and small doses to a slight increase but the differences are hardly significant.

Experiments on the relative value of different forms of nitrogenous manure, used in combination with potash and phosphates, showed that green *Boga medeloa* cuttings, sulphate of ammonia and oil-cake were satisfactory but that cyanamide, animal meal and fish manure were slow acting. Nitrate of soda gave the best results in the first three years but is now giving poor results due to the loss of tilth following on its continual use.

The cumulative effect on yield of cultivation of different types has also been studied in considerable detail.

Work was continued on the life-history and control of Red Spider and Green Fly. Cyano gas (calcium cyanide) was found to be 100 per cent. efficient for destroying the former insect in the field. Further work on Red Spider emphasised the connection between damage by the pest and the condition of the plant. In particular it was found that any pruning treatment which resulted in the retention of poor and old wood resulted in increased Red Spider infection. Hard plucking conduced to red spider attack, light plucking encouraged the leaf-rollers.

Two fungoid diseases of tea, which had not been reported previously, were investigated. One, a fungus of the genus *Ophiobolus* provisionally named *O. theicola*, attacks the woody stems of the tea plant just at the collar and spreads both upwards and downwards. The second, a common fungus, *Leptosphæria coniothyrium*, also attacks the stems at the collar but spreads only into the branches. The same fungus was found on dead branches of *siris* (*Albizzia*) and *sissoo* (*Dalbergia*) trees in the neighbourhood of infected tea.

In Southern India, research work on tea is carried out by the Tea Scientific Officer of the United Planters' Association of Southern India. During the year further progress was made with the establishment of a newly-planted area of tea and on the laying-out of an area of old tea for experimental purposes. Contour planting which at present is little used in South India, though successful in other countries, has been adopted on the steeper slopes. As in Assam, tea has been found to grow poorly in soils which are insufficiently acid and experiments are in progress on the adjustment of acidity by the use of sulphur. With a view to putting experimental work on tea manufacture on a firmer basis, considerable attention has been devoted to a study of the constitution of the tannin of tea and the preparation of alkaloidal tannates leading up to a more satisfactory method of determining tannin in solutions of different stages in tea manufacture. Work on the fungoid diseases and insect pests of tea in South India was continued, and

the annual report of the Scientific Officer contains detailed recommendations for control measures under different estate conditions.

X. Coffee.

Save for one estate in the Northern Shan States of Burma, the coffee-growing industry in India is confined to Southern India and is important in Mysore State, the Madras Presidency, Coorg, Travancore and Cochin, approximately one-half of the total area under coffee being in the Mysore State. The total area reported in 1928-29 was 160,848 acres compared to 155,839 acres in 1927-28, and the production of cured coffee was estimated at 247,844 cwts. compared to 317,539 cwts. in the previous year; exports amounted to 197,629 cwts. valued at Rs. 169·2 lakhs compared to 276,668 cwts. valued at Rs. 232 lakhs in 1927-28. The principal variety grown is Arabica :—

The Mysore Coffee Experimental Station at Balehonnur in Kadur District of Mysore State is maintained by the Mysore Agricultural Department with the co-operation of the United Planters' Association, South India, and forms the centre of coffee research in India. In particular the United Planters' Association have provided a Scientific Officer to work on coffee diseases under the direction of the Mysore Director of Agriculture. The Station was started in 1925 and marked progress has now been made in several directions. Forty acres of mature coffee have been set aside for manurial experiments and certain tentative conclusions have been drawn from three years' yields, *viz.*—

(1) The application of bonemeal gives much poorer results than the application of readily available phosphatic manures like superphosphate.

(2) Readily available nitrogenous manures like ammonium sulphate give better results than such oil-cakes as groundnut cake and are also cheaper per unit of nitrogen.

The black rot disease can be completely controlled by spraying with Bordeaux mixture during the two months preceding the S.-W. Monsoon, as also can leaf disease. The advantage of spraying on an estate scale is very marked having increased yields by an average

of 2 cwts. of coffee per acre, the net return even at the present low price for coffee being some Rs. 100 per acre. In Mysore State some 5,000 acres of coffee were sprayed in 1929. The root-rots of coffee are at present being studied by the Scientific Officer, and there is some indication that spraying may have an indirect effect in bringing them under control. But a more promising line of enquiry is the production of varieties with a resistant root system ; both Robusta and Liberica coffees are much more resistant to root-rot diseases than is Arabica ; hence the production of resistant hybrids has been undertaken. An improved technique for grafting Arabica coffee on to Robusta and Liberica stocks has also been worked out which promises to make the use of such grafts a practical proposition on coffee estates.

The coffee green bug (*Coccus viridis*) can be effectively controlled by spraying with fresh oil-resin-soap solution and this is now the standard method of control. The coffee stem borer (*Xylotrechus quadripes*) is less easy to deal with but much can be done by the collection of the beetles as they emerge and scrubbing stems to prevent the laying of eggs ; spraying against leaf diseases also assists in borer control as the adult beetle prefers exposed and unshaded areas for oviposition.

Plant-breeding work on coffee at Balehonnur is directed to the production of new disease-resistant strains. Another important preliminary step is the recognition and multiplication of high-yielding types of Arabica coffee. The experimental station now has about 15,000 trees planted from seed from some 200 selected plants from the various coffee-growing areas in South India.

XI. Rubber.

The area under rubber in India during the year 1928 was 167,016 acres as compared to 152,300 acres in 1927. The area tapped was 108,585 acres and the yield 26·8 million lbs. compared to 104,694 acres and 26 million lbs. in 1927-28. Exports to foreign countries amounted to 25·8 million lbs. valued at 199·8 lakhs of rupees compared to 25·4 million lbs. valued at Rs. 257 lakhs in 1927-28.

The United Planters' Association of South India maintained a rubber research station at Aneikulum but progress was hampered by the absence on leave and subsequent retirement of the scientific officer due to continued ill-health. The discovery mentioned in last year's report that all good yielding rubber trees had latex tubes of above a certain average bore, was further developed. Regular daily yield measurements on 240 trees were maintained and the work of classifying plants in the nursery on this basis was extended to 10,000 plants. A dozen writers from different rubber estates were trained in Mr. Ashplant's method of selection and members of the station staff were lent to various estates.

XII. Fruit.

Rather more attention has been devoted to the improvement of fruit-growing in India during the last year though progress is still slow, due mainly to lack of specialist staff.

In MADRAS, work in the Nilgiris was continued under the supervision of the Curator of the Ootacamund Botanical Gardens. Two of the fruit gardens worked at a profit and the fruit gardens as a whole covered 93·7 per cent. of the expenditure on them as compared to 77 per cent. the previous year. A fairly wide range of fruit has now been proved capable of bearing profitably under Nilgiri conditions and stocks can be supplied. 2,043 grafts and seedling fruit trees were sold as compared to 1,210 in the previous year. There is now need for expanded arrangement for demonstration and supply of young stock as well as for further experiment. On the West Coast the experimental orchard at Taliparamba gave a distinct stimulus to fruit-growing; 20,000 pineapple suckers and 279 other fruit plants were sold to ryots during the year.

In BOMBAY, work was in progress during the year on mangoes, citrus fruits, grapes, figs, bananas and pomegranates, work being carried out at the Ganeshkind Botanical Gardens, the Modibag Gardens (College Estate) and a small nursery at Alibagh, by the Government Horticulturist who has a district horticulturist for demonstration work. A special study was made of citrus stocks;

the die-back disease of citrus trees is still under study; the results obtained to date were published in bulletin form.

A special study of the marketing of mangoes was made and preliminary experiments conducted in their storage and transport. Demonstrations in mango canning were carried out at Bijapur and Ratnagiri. Work at the newly established fruit station at Mirpurkhas in Sind indicated that dates, lemons and raisin grapes showed most promise.

In the UNITED PROVINCES, the orchard industry in the Kumaon hills is developing rapidly and this area, which has long been famous for the excellent quality of its fruit, seems likely to become the principal orchard area of Northern India. Special attention has been devoted by the Government Entomologist to the question of orchard pests and disease; a special scientific assistant, on return from post-graduate training at Pusa, has recently been posted in Kumaon for these investigations. The co-operation of orchard-owners has been secured and it is hoped eventually not only to introduce modern methods of treatment of disease and pests but to investigate the inter-relation of insect and fungus attack, soil conditions, the root-systems of the various stocks and cultivation methods.

In the PUNJAB, fruit work is under the Fruit Specialist and his Assistant and is carried out on 11 Government fruit gardens in different parts of the Province. From the Government nurseries at Lyallpur and Sargodha 6,700 young plants were supplied as compared to 1,500 in the previous year, the principal demand being for oranges, peaches and plums. The Department has assisted the establishment of a number of private nurseries and 2 fruit-growers' associations. A register is now maintained of nurseries which are open to departmental inspection in order to ensure that buyers obtain plants true to type. The co-operative Fruit-growers' Associations at Montgomery and Lyallpur are also taking up packing and marketing experiments and the spraying of members' gardens—in both cases with Government assistance; the newly formed fruit growers' association at Muzaffargarh will also take up co-operative spraying. These associations materially lighten the task of the

horticultural staff who during the year paid 250 visits to private gardens to give advice. Experimental work in progress includes experiments on the irrigation of olives; the planting of dates, including the time for planting suckers, size of sucker and seasoning of suckers; the curing of dates and means of protecting ripening dates from rain; root pruning of *Santra* oranges; manurial experiments on Malta oranges and grapes; and pruning experiments with grape-vines. Many of these experiments are carried out in co-operation with private growers. Both on oranges and grapes artificial manures (sodium nitrate and ammonium sulphate) have given better results than organic manures.

The classification of mango varieties has been started by the Fruit Specialist who has secured the co-operation of the proprietors of a private nursery at Saharanpur, who have undertaken to supply fruits of the two-hundred named varieties which they grow.

Demonstrations of the improvement by top working of old fruit trees have been given on about 800 trees of *ber* (*Zizyphus jujuba*), peach, mulberry and almond.

In BIHAR AND ORISSA, a post of horticultural overseer for the Chota Nagpur Range was sanctioned during the year. The Economic Botanist maintained the supply of named mango grafts to the public, the number issued being 1,209.

In the CENTRAL PROVINCES, the important local orange (*Santra*) industry continues to expand and marketing studies have recently been undertaken, as also experiments on the growing of grape-fruit (*Citrus maxima*); satisfactory growth of grape fruit on *jambheri* stock has been recorded.

In BURMA, experimental fruit gardens have been established at the Hmawbi, Myaungmya, Mudon and Pyinmana exprtimental farms. Marked success has been achieved by the introduction of "Kew" pineapples from Ceylon.

XIII. Fodder Crops and Grasses.

One aspect of the introduction of higher-yielding varieties of the principal crops and of the increase in yield by better methods of cultivation and manuring is sometimes overlooked; these improve-

ments should automatically release more land for fodder-growing in order that the cattle of the country may be better fed. Leguminous fodder crops are doubly important in that they assist in the maintenance of the fertility of the land.

Berseem (Egyptian clover-*Trifolium alexandrinum*) again gave excellent results at PUSA on about 120 acres of irrigated land. A full supply of green fodder for grazing and cutting for the large dairy herd of 359 animals was available from November 22nd to May 16th, in addition to which 25,500 maunds from the third flush was cut and siloed—as the weather was unsuitable for hay making. The silage was brought into use 8 weeks later and found to be in excellent condition. In the North-West Frontier Province, berseem, which was introduced in 1910-11, has replaced *shaftal* (*Trifolium resupinatum*) on some 12,000 acres. Berseem is also much valued in Sind and in other Provinces. The difficulty of producing seed in India is being got over and considerable quantities are available from the North-West Frontier Province.

In Chota Nagpur Division of BIHAR and ORISSA, berseem seed was successfully produced on a small scale at both Ranchi and Neterhat. Amongst other leguminous fodder crops which have given good results at Pusa may be mentioned soy-bean—especially the chocolate strain No. 2.

Meth (*Phaseolus aconitifolius*), *guar* (*Cyamopsis psoraloides*) and cow-peas (*Vigna catiang*) are familiar crops throughout Northern India, the fodder value of which is not fully appreciated.

In BENGAL, the Second Economic Botanist is devoting special attention to fodder crops in collaboration with the Live-Stock Officer, and amongst those which show promise are :—Teosinte (*Reana luxurians*), Napier grass (*Pennisetum purpureum*) from the Philippines, Japanese millet (a type of *Pennisetum typhoideum*) Sudan grass, sunflower. An early strain of imported Sorghum (Orange sugar-corn) proved to be both very early and a heavy yielder at Chinsurah.

IN BOMBAY, work has been continued on the improvement of Deccan pastures under the Economic Botanist to Government; the results are summarized in a recent Memoir in which it is stated

that contour-bunding to stop erosion, fencing, the limitation of the number of cattle grazed, exclusion of cattle during the early monsoon period, together with the planting of shade trees and the provision of adequate supplies of drinking water and rock salt for the grazing-stock, are held to be essential to improvement; the maximum outturn from good grass-land is likely to be obtained by cutting for silage in the early part of the season followed by regulated rotational grazing, the droppings being harrowed in and supplemented, where necessary by artificial manures.

In the CENTRAL PROVINCES, the Second Economic Botanist carried out a careful study of the local grasses, the results of which have since been published. The last three years' work on the improvement of grass areas indicates that only by re-seeding the areas after light cultivation with an approved mixture of seeds can rapid improvement be expected. A suitable mixture of grasses and leguminous crops gave a yield of 3,850 lbs. of hay per acre. Investigations on leguminous fodders are being continued. *Alysicarpus rugosus*, a common leguminous weed, was found to give a satisfactory yield of fodder and to be relished by cattle.

In the PUNJAB, the Fodder Specialist continued a study of 14 indigenous pasture grasses. Of these, *anjan* (*Pennisetum cenchroides*) maintained its superiority in point of yield, *khawi* (*Andropogon iwarancusa*) being the only one which approached it. As regards power to spread in competition with other grasses ("aggressiveness") the grass known as 'Lamp' (*Aristida depressa*), a poor grass as regards bulk, headed the list with *khawi* second; the plot of *anjan* and *khawi* kept absolutely pure. Three cultivated perennial grasses were under trial, *viz.*, Elephant grass (*Pennisetum purpureum*), Guinea grass (*Panicum maximum*) and Rhodes grass (*Chloris Gayana*); the highest yield was given by Elephant grass. Of the numerous cultivated leguminous fodder crops tried, berseem gave the best yield with *shaftal* second. Imported fodder *juar* (*Andropogon Sorghum* var. *saccharatum*) was grown in rotation with pulses in the succeeding *kharif* and did better after berseem than after *shaftal*. Work on the setting of seed by *berseem* in the Punjab has been started. In variety trials at Lyallpur with lucerne

(*Medicago sativa*), the South African varieties known as 'Chinese' and 'Tamworth' maintained their superiority.

In most Provinces increased attention has been devoted to silage and to demonstrations of silage-making. In Bihar and Orissa the question of small scale silage-making, *i.e.*, on a scale suitable to large cultivators and co-operative societies, is receiving special attention at the district farms. There is no way in which the feeding of Indian cattle could be more easily and more generally improved than by the more general adoption of silage.

XIV. Millets.

The Royal Commission on Agriculture drew attention to the extreme importance of more work on this group of important crops which occupy some 38 million acres annually.

In the Madras Presidency work on this important group of crops is under the Millet Specialist at Coimbatore, and a thorough study of the millets of the Province, and of the economic botany of the more important of them, is now in progress. Breeding work is now being extended to sub-stations as in the case of cotton and rice. A special Millets Botanist with a small staff was appointed in the Punjab during the year 1927-28, and systematic work has been started on the Punjab millets.

In the Central Provinces work on *juar* has occupied a prominent place in the programme of the Economic Botanist for some years and several improved strains have resulted.

In Bombay the work on millets is under the direction of the Economic Botanist.

Juar (*Andropogon Sorghum*) is an important grain crop in Bombay, Madras, the Central Provinces and Hyderabad and in the United Provinces, and in these Provinces the dry stalks also form a very important part of the fodder supply. In other Provinces *juar* is grown mainly as a fodder crop and is suitable both for green fodder and for ensilage. The total area under *juar* in British India in 1928-29 was 11,507,000 acres.

The area under improved varieties of *juar* in the CENTRAL PROVINCES reached 129,773 acres as compared to 107,977 acres in the

previous year. Of this area, 112,807 acres was in Berar. The amount of improved *juar* seed distributed by the Department was 6,107 maunds and there were 755 private seed farms growing these improved varieties, mainly Saoner and Ramkhel, as compared to 572 in the previous year.

In MADRAS an improved yellow *juar* "T. 6," evolved at the Nandyal Experimental Station, has proved very suitable to the Kurnool and Cuddapah Districts and now occupies 10,165 acres; a selected type of white *juar*, produced at the Coimbatore Millet Station, is now being finally tested prior to distribution.

In BOMBAY, a study of the *juars* of the Karnatak was completed and published during the year. Very striking results were obtained by the use of graded *juar* seed, and on 90 cultivators' plots the increase in yield by grading varied from 30 to 89 per cent. for unirrigated crops and 43 to 77 per cent. for irrigated crops. The grading is performed with suitable hand sieves, and 574 of these were supplied during the year.

Ragi (*Eleusine coracana*) is of particular importance in Madras and Mysore. The type known as T. 8 evolved at the Hagari Experimental Station now occupies 2,143 acres, but the newer type E. C. 47 from the Millet Breeding Station has proved definitely superior at Coimbatore and is being distributed in that district.

In Mysore, 15 seed-farms were organised for the multiplication for general distribution of the three high-yielding types of *ragi* evloved by the Botanical Section and tested at the Hebbal Experimental Farm. Rotation experiments continued to show improved yields of *ragi* after groundnut or *arhar* (*Cajanus indicus*).

Bajra (*Pennisetum typhoideum*) occupies some 14 million acres annually in British India. Work on this crop is now in progress at Lyallpur, Coimbatore and Poona. At the last named station, where a special investigation on this crop is financed from the Sassoon David Trust Fund, seven promising varieties have been isolated; two of which have been definitely proved to be high yielders but unfortunately neither differs materially in appearance from the ordinary *bajra* crop of the neighbourhood. An attempt is now

being made to get over this difficulty by breeding high-yielding varieties with coloured stems.

XV. Other Cereals.

Maize. Of an area of some 6 million acres under maize in British India, about 60 per cent. is to be found in the Punjab, United Provinces and Bihar. In the Punjab, maize is included in the programme of the Millet Botanist who now has a number of varieties under study.

In the United Provinces, 'Jaunpur' maize continues to be popular and the same type is useful in North Bihar. More progress has been made in North Bihar by improved cultivation and manuring than by change in variety; proper interculture and ridging (with the Bihar cultivator and ridging plough respectively) have led to increased yields and have enabled maize to be successfully cultivated on land otherwise somewhat too low-lying. Manurial experiments with maize at Sepaya have shown a very definite response to phosphatic manures. In Orissa, Kalimpong maize is popular; a very early Sabour selection of a local maize promises to be valuable on *diara* lands which are liable to flooding during the later portion of the *kharif* season.

Barley. At the Pusa Research Institute a number of pure-line strains of barley have been isolated, and a tentative classification of the different forms of Indian barleys has been practically completed. Varietal trials of the most promising strains place type B-4 as the highest yielder: some of the seed has been distributed locally to planters with satisfactory results. These types were also supplied to the United Provinces Department of Agriculture.

In the United Provinces, the principal barley-growing province, early heavy-yielding types have been isolated which it is believed will also meet the requirement of export trade as several possess high malting value.

Oats (*Avena sterilis* Linn.). The Pusa selected types B. S. 1 and B. S. 2, referred to in last year's report, again gave very satisfactory results both in the large-scale tests on the Pusa farm and on the Botanical Area and may definitely be classed as high-yielding:

they possess, in addition, the valuable property of smut resistance. Sixty-one maunds of seeds of these varieties were supplied to Agricultural Departments and to planters during the year. The study of crosses between the B. S. type and " Abundance " and " Scotch Potato " oats was continued. As pointed out last year, the work of Dr. Shaw and his collaborators has shown that the cultivated oats of India belong to the species *A. sterilis* L. (sub-species *culta*) and not to *A. sativa* Linn., as shown in all important flora and most other reference books.

XVI. Potatoes.

This crop is steadily growing in importance but development is checked by difficulties in the supply of disease-free sets and the loss to potatoes in storage caused by the potato moth and by disease.

In the UNITED PROVINCES, special attention has been given to the question of the control of mosaic disease of potatoes and with successful results. One imported variety has proved superior to local varieties and is being tried as a summer crop at three hill stations—it is hoped to maintain vigour and eliminate the problem of storage of tubers for planting purposes by growing the crop alternatively in the hills and the plains. In the PUNJAB, experimental work on potatoes is carried on in eight villages near Mashobra in the Simla hills. Five varieties of Scotch potatoes introduced in 1909 were again grown for multiplication and supply of sets. These varieties during the year under report averaged 100 maunds per acre compared to 78 maunds from the *desi* varieties. Nine new Scotch varieties imported in 1929 are also under trial, as also are three English varieties imported in 1924. Some new *desi* varieties have also been raised from true seeds obtained in 1918: three of these have been retained after selection. It has been found that of the imported Scotch varieties five produce viable pollen and it is now proposed to use these for hybridisation in the hope of obtaining superior varieties for Punjab conditions. In 1927 it was found that practically all the varieties of potatoes under experiment were affected with one or other of the diseases—" Mosaic "

and "Leaf Roll." A start has been made in raising a stock of sound tubers from disease-free plants.

In MADRAS work on this crop is carried out at the Nanjanad Potato Experiment Station in the Nilgiri Hills. Heavy dressings of farm manure and deep cultivation were found essential, and the supply of manure was increased by using large quantities of bracken and weeds as litter. Varietal tests were continued. The minor millet *samai* (*Panicum miliare*), a new crop in this locality, proved an excellent rotation crop for potatoes and a demand for seed rapidly sprang up. At the Upper Shillong Farm in ASSAM variety testing and acclimatisation experiments were continued with 26 imported varieties. A recent introduction, Ben Lomond, gave the highest outturn of 11,480 lbs. per acre, other good yielders being Windsor Castle (9,323 lbs.), Imperator (9,266 lbs.) and Abundance (8,897 lbs.). Of the older importations, King-of-Potatoes (9,647 lbs. per acre) and British Queen (8,651 lbs. per acre) did well. These varieties are popular with cultivators in the Khasia and Jaintia Hills, as are several others of the older importations, but are reported to become liable to disease when continuously grown in the same locality. Darjeeling potatoes gave good results in the Assam Valley and Silchar potatoes in the Surma Valley. Some preliminary experiments on storage using Hycol as an antiseptic gave promising results.

XVII. Beans and Pulses.

This group of crops is important from every point of view. As rotation crops they are intimately concerned with the maintenance of soil fertility; for a population which is largely vegetarian they form an article of diet of primary importance; they provide part of the concentrated food for working cattle and certain pulses are an important item of export. If falling prices for cereals and fibre crops, coupled with the use of higher-yielding varieties of these crops (thus maintaining the same standard of production on a smaller area), leads to an increase in the area under pulses, the eventual gain to the agriculture of the country might be considerable.

Gram. One of the most important of the pulses is gram (*Cicer arietinum*), the area under which in 1928-29 was 14,387,000 acres, the area in the principal gram-growing Provinces and States, being as follows :—

Madras	74,000
Bombay (including Sind)	774,000
Bengal	143,000
United Provinces	5,424,000
Punjab	4,160,000
Burma*	93,000
Bihar and Orissa	1,288,000
C. P. and Berar	1,308,000
N. W. F. P.	193,000
Ajmer-Merwara	61,000
Coorg	1,000
Delhi	15,000
Hyderabad	853,000
	14,387,000

The recorded area under improved varieties was 216,513 acres, of which 168,116 acres were in Burma and 48,000 in the United Provinces ; the total figure known to be an under-estimate since the returns from most Provinces include the area under improved varieties of gram under other crops. Two of the Pusa grams which were isolated by the Howards some years ago form the bulk of the area under improved grams in the UNITED PROVINCES. Work on gram at PUSA has been continued and during the year under report, the isolation of the unit species was completed, 61 new types having been obtained which, with Howard's original 25 types, make a total of 86 distinct varieties of the crop. Type 86 appeared as a mutant in type 24 in 1927-28 and appears to be a case of gigantism—a cytological comparison of the mutant and parent has still to be completed. The description and classification of the new types is in progress of publication. A considerable amount of further knowledge has been obtained on the genetics of this crop.

In BIHAR AND ORISSA work on gram is being carried out in close co-operation with the Imperial Economic Botanist. Both the Sabour 4 and Pusa 17 types are popular and are being distributed in suitable districts. In BENGAL, Pusa 18 gram has been reported to have done well at Rajshahi.

In the CENTRAL PROVINCES, an attempt is being made to isolate high-yielding and wilt-resistant types of gram.

In BURMA, the estimated area under Karachi gram, originally introduced because it was wilt-resistant, amounted to 168,116 acres, the amount of seed distributed during the year was only 128,294 lbs., but the new variety is firmly established and in Minbu District, for example, has almost completely ousted the local wilt-susceptible variety. Work in the Botanical Section at Mandalay is largely directed to the securing of a series of strains of gram of different life-periods suitable for different soils.

Pigeon-pea—Arhar (*Cajanus indicus*). Work on this important *kharif* pulse is in progress at Pusa and in most Provinces. The work at PUSA has been directed to the breeding of wilt-resistant varieties and to a botanical classification of the crop with the isolation of unit species. The work on unit species has been completed and is now under publication. The number of distinct types described is 107 and these cover a wide range of height, habit and length of growing-period as well as of flower-colour and shape. From a taxonomic standpoint, the flower-colour, seed characters and pod characters are the most useful, but from the economic point of view the agricultural characters of habit and time of maturity are of great importance. The investigation on wilt-resistant types, carried out in collaboration with the Imperial Mycologist, is nearing completion. Types with a high degree of wilt-resistance which are also good yielders have been isolated. A further year's study of crosses between resistant and susceptible types is necessary to clear up the question of the correlation between certain morphological characters and wilt-resistance. Several of the new types have given good results on the Pusa farm, at Sepaya in North Bihar and at Sabour in South Bihar. The provision of a number of types

of *arhar* known to be resistant to the wilt disease now seems within, sight—these should prove of great use to several Provinces.

In BIHAR work has been started, in collaboration with the Imperial Mycologist, on a 'sterility' disease to which many varieties of *arhar* are susceptible and which is fairly common in South-East Bihar—several of the new Pusa types were distinctly resistant to this disease whatever its nature, whilst others were quite susceptible.

In the CENTRAL PROVINCES, several distinct types of *tur* (the early form of *Cajanus indicus*) have been isolated and tested. One of these is likely to be in demand as it yields well and has a good quality and flavour—an important consideration in the case of this common food pulse.

In BURMA, two selected strains C. 8 and C. 10 were multiplied for distribution by the Botanical Section, having found favour with cultivators in the Sagaing and Mongwa areas. Strain C. 10 is of special value in having proved immune to a malformation common in *Cajanus indicus* in those districts which results in failure to set seed.

Beans. Work on Lima beans has been continued in BURMA, the object being to find a substitute for Rangoon white beans *Pebyugale* and for the red Burma bean *Pegya*. As in previous years, the Moki Lima bean yielded better than the Sieva Pola Lima, Lewis Lima and Henderson Bush Lima varieties, not only on the Botanical Section at Mandalay but at Amarapura, Mahlaing and Tatkon. The complaint that the Moki Lima had a thicker seed-coat than the white Rangoon bean was shown to be groundless as examination showed that the seed-coat of Moki Lima was actually slightly the thinner of the two. Trial shipments of 5 tons each of Moki Lima bean to Japan and London were made through the Burma Chamber of Commerce. The Japanese shipment evoked a very complimentary report on the superior quality of the bean and its suitability for Japanese consumption, but the consignment realised an unsatisfactory price. The London shipment fared better, the price realised being equivalent to Rs. 6-1 per basket of 69 lbs. at Tatkon (after all expenses had been deducted) and the report stated

that the bean would sell in London at £2 per ton above Burmese *Pebyugale*—a similar valuation on direct samples was furnished by the Imperial Institute. Some four years ago the valuation of Moki Lima bean for shipment to London was Rs. 640 per 900 lbs. compared to Rs. 310 for *Pebyugale*. In 1927-28, the latter bean reached the phenomenal price of Rs. 600 per 900 lbs. largely due, it is said, to the failure of the Manchurian bean crop. There is hence some uncertainty as to the preminum which Moki Lima beans will command; further trial shipments are being arranged and a cautious policy in seed distribution is being followed meanwhile. The isolation and testing of pure strains of Lima beans is in progress and a study of the inheritance of characters in both the imported and indigenous varieties is in progress in the Botanical Section.

Lentils (*Ervum lens*). A botanical study of this very important food-pulse has been in progress at the Pusa Research Institute for some years. Sixty-six types of lentil have been classified and described and the results are now in course of publication as a Memoir. A number of promising types are now undergoing field trials. A study of the inheritance of the various morphological characters is in progress. It has been shown that a spreading habit is dominant to erect habit. The inheritance of white and violet flower colour is somewhat unusual but will probably be cleared up in the next generation of hybrids.

CHAPTER III.

RESEARCH AND INVESTIGATION.

In the summary of economic work on crops given in the previous chapter reference has been made to a great deal of the research work in progress particularly in Economic Botany but also in other branches of agricultural science. In this chapter an attempt is made to refer briefly to some of the research work in progress on fundamental problems in the different branches of agricultural science and to some of the results obtained. More detailed information will be found in the Scientific Reports of the Pusa Agricultural Research Institute and in the reports of the research officers of the various Provinces.

I. Soils.

Surveys. Soil surveys by the accepted chemical methods are not called for in all parts of India. Over large areas the soils are unusually uniform and of easily recognisable types, and this consideration led the Royal Commission on Agriculture to recommend that soil surveys should not be undertaken as part of a general routine but only in connection with the solution of definite problems. This indeed is in accordance with the accepted policy of the various Agricultural Departments who have recognised that there are many soil problems which are more urgent than routine surveys. On the other hand, there are many tracts where soil surveys are needed; unfortunately financial considerations have held up work in some of these.

In MADRAS, the soil survey of Malabar was finished and published, thus completing a series of six soil surveys intended to throw light on the manurial requirements of the important paddy tracts of the Presidency.

In BURMA, soil surveys of the Mandalay canal area and of the Pegu District were continued, the majority of the samples for the latter area having been collected; pressure of more urgent work delayed progress to some extent.

In ASSAM, no progress could be made with the soil survey of the Jorhat sub-division owing to lack of laboratory staff.

Base Exchange. A study of the replaceable bases of Burma soils was continued by the Agricultural Chemist at Mandalay. The Agricultural Chemist, Bihar and Orissa, continued a study of base exchange in Orissa soils. Ordinary analysis did not reveal any positive difference between soils on which crops were definitely good and bad, but when these soils were treated with normal solutions of neutral salts, the differences found in base replacement were considerable.

Soil acidity and lime requirement. Harrison's work on the antimony electrode method of determining the hydrogen-ion potential of soils was published as a Memoir during the year. One great advantage of the method lies in the fact that the electrode need only be dipped in moist soil, and that under these conditions sharp, satisfactory and reproducible readings are obtained which give values in excellent agreement with those determined on soil suspensions by the hydrogen electrode. This removes a practical difficulty in regard to the determination of the pH of highly acid soils, especially those of a lateritic character.

An apparatus has been designed for use in the field which, in addition to being portable, has the great advantage that the soil samples do not require to be submitted to any manipulative processes in order to carry out the pH determination. The standardisation of the antimony electrode has been carefully studied; it is essential that it should be standardised by means of the instruments with which it is to be employed. The general handiness of the antimony electrode makes it eminently suitable for determining the amount of lime required by any particular soil in order to bring it to neutrality or to any other degree of alkalinity or acidity desired.

In BIHAR AND ORISSA, the antimony-electrode method is being applied by the Agricultural Chemist to the determination of the lime requirements of Ranchi and Sambalpur soils.

In SIND, determinations of the pH of a number of Sind soils at the Sakrand Research Station (method not stated) showed that

the pH of these soils varies from 8·5 to 9·5 and that the growth of crops, especially cotton, on soils with a pH above 9 was extremely poor; good growth was obtained up to about 8·8.

In BENGAL, the Agricultural Chemist has continued to experiment on the hydrogen-ion concentration in the 'puddle' prepared for the transplantation of paddy. The results confirm the previous conclusion that, with the acid soils of Dacca, the application of lime in just sufficient quantity to produce a neutral reaction, gives an appreciably increased yield of grain and straw. At Rajshahi where the soil is slightly alkaline, the use of superphosphate in quantity just sufficient to create faint acidity also led to an increase in yield.

In ASSAM, thorough work on the acidity of tea soils has been carried out by the scientific staff of the Indian Tea Association. A reference has already been made in Chapter II to the fact that tea requires an acid soil. Considerable difficulties were met with both in electrometric measurements and in colorimetric estimations of the pH of soil extracts. High temperature in the hot weather led to abnormal results and the quantity of soil left in suspension had a considerable influence on the results.

Soluble potash in soils. At the Tocklai Experiment Station of the Indian Tea Association a consideration of the analyses of a number of tea plots that had been under regular manuring for a number of years led to the conclusion that the determination of water-soluble potash in a tea soil gave a more useful indication of its potash requirements than a determination of citric-soluble potash. It was also found that the ratio of soil to water used greatly affected the concentration of potash in the water extract. The concentration of potash in the solution tended towards a constant when very high ratios of soil to water were used. Since a 1:2 ratio of soil to water is the highest that can be conveniently handled, it was proposed to adopt this as standard.

It has also been shown that the use of sodium nitrate as a manure over a series of four years had no effect on the concentration of soluble potash in the soil.

Soil colloids. The Physical Chemist at the Pusa Research Institute studied the factors influencing the dispersion of soil colloids

in water. It appears that the nature of the exchangeable ion has an important influence on the state of dispersion of the soil. The presence of sodium on the clay complex is associated with high dispersion and, on drying, such clays show the intractable condition common in alkali tracts. The presence of calcium leads to a lower dispersion and a workable soil, but it is noted that when sodium is replaced by calcium, the difference in texture is not evident until the clay has been dried and re-dispersed—a fact which may have an important application in the reclamation of alkaline soils. Soils rich in exchangeable sodium required much larger quantities of any flocculating agent to cause coagulation than do those containing exchangeable calcium. It was also found that most of the methods proposed for the estimation of soil colloids are influenced by the nature of the exchangeable bases present. A new method of dispersing soils for mechanical analysis, based on the easy dispersibility of soils saturated with sodium ions, was worked out and published. A new percolating cylinder for measuring the permeability of soil to water was devised and a description published.

Reclamation of alkali land and movement of alkali salts. In SIND, the possibility of reclaiming salt (*kalar*) lands is increased by the relative absence of the most obnoxious salt (sodium carbonate) and the presence of a sandy layer below the soil. At the Sakrand Research Station experiments were conducted by two methods. In the first, the salts were driven down by an initial heavy flooding and, on land containing 1 to 1·3 per cent. of soluble salts, fair crops of cotton, *juar* and *bajri* were obtained with applications of 12″, 16″ and 20″ of water, the heaviest application giving the best results: an initial dose of 8″ of irrigation water was insufficient. Other work at the station indicated 0·5 per cent. of soluble salts as the maximum concentration which crops could tolerate without sustaining serious damage. The second method involved the use of calcium chloride in order to replace sodium in the clay complex by calcium. The clacium chloride was applied at the rate of one-quarter, one-half and one ton per acre with the intention of observing the effect over three years without further applications. In the first year of the experiment, crops germinated well

on the calcium-treated portions of the worst *kalar* strip—no germination occurred in the untreated strips. In the second year the differences were not so marked as the irrigated water used had washed the *kalar* salts down sufficiently to permit of germination on all portions of the plot. The calcium treated plots showed a pH of 8·8 as compared to 9·1 on the untreated plots. The effect of different quantities of irrigation water on the soil moisture content and on the movement of salts was also studied at Sakrand. The work is not complete but the preliminary indications are that following an initial flooding, an application of 2″ of water every 10 days is more effective than an application of 3″ every 15 days, both in maintaining the moisture supply in the first five feet of soil and in checking the rise of salts to the surface. It may be remarked, however, that it is exceedingly difficult to secure applications of 2″ of irrigation water in actual practice under village conditions.

Some preliminary experiments on the lateral movement of water and salts in the neighbourhood of water-courses have given interesting results: the rate of such movement depended greatly on the degree of compactness of the soil with which it varied directly. Further work is in progress but it is believed that undesirable lateral movements of moisture and salts can be checked by small trenches parallel to the water-courses. The importance of this work to the future of Sind agriculture is obvious. The completion of the Lloyd Barrage Canals will bring to a practically rainless tract of flat country, with a fairly high sub-soil water level and with salt-impregnated soil, perennial canal irrigation involving an entirely new system of agriculture. Unless the water is used to the best advantage and its distribution scientifically controlled, the full benefit of this great irrigation scheme will not be realized; indeed the whole success of the scheme depends on the solution of such problems as those outlined above. Unfortunately, the Agriculture Department in Sind is far too small and poorly financed to undertake more than a tithe of the urgent work awaiting it.

In Travancore State the reclamation of alkali land by applications of calcium chloride or of sulphur were continued. On paddy lands at Nagercoil farm, sulphur ploughed in at the rate of half a ton

per acre for two years, followed by flooding to wash out the salts, gave promising results.

Soil moisture movement. At the Pusa Research Institute a post-graduate student (Mr. A. T. Sen) completed a study of the rise of moisture in soils under field conditions which is under publication. The data now obtained confirm the important deduction first made by the Imperial Agricultural Chemist (Dr. J. W. Leather) 20 years ago, *viz.*, that during dry weather water moves upwards from a limited depth only.

In BENGAL, the Agricultural Chemist has started experimental work on the percolation of water through soils with the object of determining the relative moisture-retaining capacity of various soils, especially of limed and unlimed laterite soils.

II. Maintenance of Soil Fertility.

In SIND, special attention is being directed to this problem at the Sakrand Research Station. The provision of perennial irrigation in a large tract with a negligible natural supply of organic manure can otherwise hardly fail to lead to the rapid deplotion of soil fertility unless steps are taken to introduce agricultural rotations which will correct these undesirable tendencies. The fact that the presence of alkali salts encourages the tendency for land under constant irrigation to fall into 'bad heart' due to an unsatisfactory mechanical condition, accentuates the problem. Unfortunately the cropping scheme presumed in the Lloyd Barrage project does not meet this difficulty and the agricultural section at Sakrand is investigating alternative systems of agriculture. Four of these involve the inclusion of berseem (Egyptian clover), the leguminous fodder crop which plays so important a part in the maintenance of fertility under canal irrigation in Egypt.

In the UNITED PROVINCES, a study of the nitrogen balance under various systems of sugar cultivation has been carried out over a series of years. One important result of this investigation is that there are two critical periods in the growth of the sugarcane plant, *viz.*, May and early June, when the root-system and tillers develop, and August-September, when the main sugar storage

occurs. The yield of sugar per acre is closely correlated with the amount of nitrate in the soil in the first period. The nitrogen required by a crop of 800 maunds of cane per acre can be obtained by green-manuring with sann-hemp, provided that the necessary water to ensure the rotting of the green manure is available, either from rainfall or irrigation, (eight inches per acre) during the August-September preceding the planting of the sugarcane.

At the RESEARCH STATION OF THE INDIAN TEA ASSOCIATION, complete weekly records were again maintained of the nitrogen present in the soil, as nitrate and as ammonia, in seven plots variously manured; each plot was replicated five times. The normal rapid increase in nitrates from the low value of the winter again occurred immediately after the spring rains in April, the maximum being reached above the middle of May. The addition of phosphates and potash made no significant addition to the accumulation of nitrates but additions of nitrate of soda during the period of rapid nitrification led to an increase of soil nitrate considerably in excess of the nitrate added—a result of considerable interest and practical importance. Later records show that added nitrate remains in these soils for about 2 months only, thus indicating the desirability of small regular additions for such a crop as tea in preference to single large doses. Unfortunately the constant application of sodium nitrate leads to loss of tilth on these soils, thus preventing the correlation of crop yields with the nitrogen applications. Experiments with ammonium sulphate have been started in the hope of getting over this difficulty.

III. Nitrification.

The Imperial Bacteriologist, Pusa, found that the toxicity of sodium carbonate for nitrifying organism was much less than stated by earlier workers. In Pusa, Kalol and Chinsurah soils doses up to 0·2 per cent. stimulated nitrification, higher doses retarded nitrification, whilst concentrations above 0·5 per cent. suppressed it. Sodium sulphate in quantities up to 0·5 per cent. had no effect on nitrification in Pusa soil, nor had sodium chloride up to 0·2 per cent., but a concentration 0·6 per cent. of the latter salt proved toxic up to

the 8th week of nitrification. A study of two acid soils from Chota Nagpur showed that maximum nitrification took place when twice the amount of lime, indicated as the lime requirement of the soil by the Hutchinson-Maclennan method, was used; linseed grown in this soil in pots also required this amount of lime for healthy growth. In Assam soils from Karimganj the addition of calcium carbonate up to the amount indicated by the Hutchinson-Maclennan method improved the nitrification of calcium cyanamide.

IV. Nitrogen Fixation.

The Imperial Agricultural Bacteriologist carried out a further series of experiments on the ability of green algae to fix atmospheric nitrogen. Three to five times as much nitrogen was fixed in the months of June-October as in December-April. The nitrogen-fixing power of some soils was tested and the importance of liming acid soils was clearly indicated.

V. Assimilation of Nitrogen by Rice Plants.

The demonstration by the Plant Biochemist at the Pusa Research Institute of the occurrence of bacteria inside the roots of the rice plant which fix atmospheric nitrogen throws new light on the nutrition of this plant and opens up a wide field of future work. Bacteria from inside the roots of rice plants were grown in culture solutions containing sugar and minerals but free from nitrogen; slimy bacterial growths were observed, anaerobic conditions favoured their development and microscopic examination revealed the presence of characteristic capsulated bacteria. The assimilation of nitrogen from the air was confirmed by analysis, as much as 5 milligrams per 250 c. c. of culture solution being obtained. It may be remarked that the nodule bacteria of legumes show comparatively little activity when inoculated on substrates, indeed several investigators have failed to obtain any nitrogen assimilation under laboratory conditions while those who obtained positive results usually reported such figures as 2 to 3 milligrams per 100 c. c., *i.e.*, amounts comparable in magnitude with that now obtained from the rice-

root bacteria. These organisms are of special interest in that they thrive and fix nitrogen under anaerobic conditions and are being studied further.

VI. Manures and Fertilizers.

At no time has there been a greater need in India for exact knowledge on the profitable use of fertilizers than at the present day. The world fall in the prices of agricultural commodities, which had by no means reached its limit at the end of the year under report, calls essentially for more efficient methods of agricultural production. In India with a low standard of yield per acre such an increase in efficiency is frequently synonymous with an increase in yield. This may seem paradoxical when the world's production of agricultural commodities appears to be greater than the effective demand, but even in times of depression the economic production of the required amount of a given commodity on a smaller area is much-to-be-desired in India where the pressure on the land is intense and when insufficient areas are devoted to fodder crops for the live-stock of the country and to accessory foodstuffs for the human population.

Manuring for higher crop production is purely a business proposition and much more exact knowledge is needed. A new light has been thrown on the perennial problem of the use of cow-dung for domestic fuel by recent investigations at Lyallpur where the fuel value of cow-dung is compared with that of other fuels and with its manurial value under irrigation conditions. Briefly the result is that the same amount of heat was given by four annas worth of cow-dung, eight annas worth of coal and 20 annas worth of charcoal. An average family used about 2·4 tons of dung-cakes per year which gave about 6 tons of farmyard manure. If this manure were applied to irrigated land on the experimental farm at Lyallpur, it would mean an increased income of Rs. 52 per annum but, on the other hand, the average family would, in lieu of extra income from crops, require to spend Rs. 33 on coal, or Rs. 84 on charcoal, to provide fuel for domestic purposes.

In general it may be said that the use of cow-dung as fuel in villages is not always as uneconomic as it appears and that the practice will die hard. More might be done perhaps by the provision of other fuels in towns to reduce the amount of cattle-dung sent in from the country. Generally speaking, however, other methods of maintaining soil fertility and of increasing crop production must be sought. Provided that a certain minimum amount of organic matter is supplied, the recuperative power of most Indian soils is very considerable. Green-manuring affords one important means of achieving this. Reference has already been made to the success achieved with green-manuring for sugarcane in the United Provinces; on the Deccan canal area the practice is also common amongst large cane-growers; the use of green manures combined with phosphatic fertilisers for rice has become a regular practice in Madras; green-manuring is also extending in Bengal. But in many areas, especially for *rabi* crops, difficulties exist either in ploughing in the green crop in time or in securing an adequate supply of water for its decomposition. Hence other means of supplementing the scanty supply of bulky organic manures are needed and here the preparation of artificial organic manures and composts, by which weeds and crop refuse are turned into useful manure, is a most promising line of advance. In Bengal a method has already been standardised. In Madras considerable progress is reported and cotton stalks have been successfully composted and the best method of including additional nitrogen and phosphates in such composts is now being investigated. At the Indore Institute of Plant Industry, methods of compost-making which do not involve the use of artificial starters, but which do involve the crude material being used as litter in cattle sheds, have been worked out in considerable detail and the results will shortly be published. In Bihar experiments are in progress with the object of determining the best way of using dry sugarcane trash for compost manufacture.

Nitrogenous fertilizers. The result of several years' work in MADRAS with calcium cyanamide has recently been compiled and published: at present price its economic value for paddy is doubtful. Nor does nitrate of soda pay so well as green manure

for paddy. The value of ammonium sulphate in combination with phosphates is under trial. Experiments at MANDALAY with the new synthetic fertilizer urea showed that as a paddy manure it did not give as large an increase of crop as sulphate of ammonia, and that there is a distinct danger of loss of fertilizer by seepage through the bunds, or when changing water, when this fertilizer is used.

On experimental farms in the irrigated Mandalay canal areas and in the average rainfall tracts of Lower BURMA, the various ammonium phosphate manures all gave very profitable results when applied to the rice crop but at the Akyab and Mudon farms in the high rainfall area no appreciable result was obtained either with these or with ammonium sulphate. A special investigation has been started to determine whether this is due to soil conditions or to high rainfall and the washing out of the manures.

In the PUNJAB manurial experiments with cotton at Lyallpur and Khanewal yielded interesting results. Very definite increases of yield resulted from an application of ammonium sulphate in September, thus confirming the deduction made from the plant development curves and from other experiments that the proper development of flowering and bolling is largely controlled by the supply of available nitrogen at critical periods.

Phosphatic fertilizers. In experiments at PUSA with three types of rock phosphates—Trichinopoly nodules, Radiophos and Singhbhum phosphate—none of the phosphate was solubilised in 12 weeks by cultures of nitrifying organisms, although 34 per cent. of the phosphate in tricalcium-phosphate was made soluble in that time.

Solubilized bonemeal gave very satisfactory results as a manure for wheat and for grain, giving results much superior to bonemeal and as good as superphosphate. The process used was described in last year's Review and consists briefly of composting bonemeal with soil, sulphur, sand and charcoal.

At SABOUR (Bihar), the Agricultural Chemist continued his experiments on the most profitable nitrogen-phosphate ratio for South Bihar and found that this varied considerably with the locality as might be expected, since these soils are deficient in

phosphate in varying degrees. Generally speaking, equal quantities of N and P_2O_5 (applied in the ammonium phosphate type of fertilizer) gave the best results. The effect of phosphates on the ripening of sugarcanes was also studied and the conclusion reached that while the use of phosphates had no effect on the ultimate richness of the juice, it led to sharper ripening and the maintenance of a high degree of purity in the juice for a considerable period. In TRAVANCORE the use of both superphosphate and Ammophos for sugarcane and paddy is extending.

VIII. Plant-breeding and genetics.

Many references to the work of the year in this branch of agricultural science have been made in Chapter II in describing economic work on the different cultivated crops. In the course of the work in progress both at Pusa and provincial research stations a considerable amount of knowledge has been accumulated about the inheritance of characters in economic plants, the mechanism of pollination and other scientific questions associated with plant-breeding by modern methods. Unit species of many field crops have been isolated and described and the best of them tested on a field scale. Thus plant-breeders in India, as a result of work which has been going on continuously for over 20 years, are now in a position to apply more precise methods to their problems and have at their disposal a mass of valuable material as a starting point for new work. For details, reference must be invited to the Memoirs and Bulletins of the Imperial Department of Agriculture, the Scientific Reports of the Pusa Research Institute and those of provincial research officers. To single out special investigations for mention is difficult, but among other items of considerable scientific interest may be mentioned the study of the dehiscence of cotton anthers by Trought at Lyallpur, Youngman's work at Nagpur on the development of the cotton fibre, studies in sugarcane roots at Coimbatore, the researches on the Indian pulses and on chillies at Pusa, investigations on the Indian grasses at Poona and at Nagpur, and a classification of the United Provinces rices by the Economic Bota-

nist, Cawnpore. Of interesting work still in progress at Pusa may be mentioned the study of hybrids between Indian and European oats (*A. sterilis* and *A. sativa*), the linkage between certain morphological characters and wilt resistance in *Cajanus indicus* and the further study of hybrids between Indian and American types of tobacco.

IX. Plant Pathology.

Much of the work on plant diseases also has been referred to in Chapter II, and the 18 publications detailed in Appendix XIII give an indication of the extent to which work in this branch of agricultural science has progressed. The important " virus " diseases, including the mosaic diseases of sugarcane and potatoes, have received considerable attention but demand much more detailed investigation both as to the vectors of each disease and the course of the disease itself including transfer from one host to another.

Work at Pusa on *Fusarium vasinfectum*, the wilt disease of *Cajanus indicus* (*arhar*), has led to the isolation of disease-resistant types. The conclusion reached last year, that superphosphate manuring encourages *arhar* wilt and green-manuring discourages it, has been confirmed. Work on cotton wilt at Dharwar is still far from complete. The " wilt " disease of the *Piper betel* in Bengal was further studied at Pusa. This year *Rhizoctonia solani* was much more important than *Phytophthora* or *Sclerotium*. Spraying was successfully introduced in several gardens and the disease controlled. Four diseases of cinchona were also studied at Pusa. Of very considerable interest are the observations at Pusa of *Helminthosporium sativum* on wheat during the season 1928-29 when it appeared in epidemic form. Determinations, for different varieties, of the area of leaf-surface discoloured yielded interesting results. At Pusa itself, Pusa 4 was affected to the extent of 40 per cent.; Pusa 12, 16 per cent.; Pusa 52, 18 per cent.; and bearded Federation, 31 per cent In 20 cultures of some crosses between Federation and Pusa 4 grown at Karnal, the affected leaf-surface varied from 0·3 per cent. to 10·6 per cent.; of 19 cultures between Federation and Pusa 52, two had no disease at all, others showed an affected

leaf-area ranging from 0·8 to 11 per cent. That the attack was comparatively local is shown by the fact that in two other localities Pusa 52 was affected to the extent of 0·43 per cent. and 1·5 per cent. of the leaf-area only.

Rust was much less noticeable than usual on wheat at Pusa—the same method was applied to determine the percentage of leaf area affected by orange rust and yellow rust on various varieties.

X. Entomology—Insect Pests.

Much of the work on the major insect pests of cultivated soils has already been referred to in Chapter II. Sugarcane pests were further studied at PUSA and further information collected about the borer *Scirpophaga nivella*. The life-history of the sugarcane Aphid (*Aphis Sacchari*) was worked out. The borers present in wild grasses were also studied. Work on *Neomaskellia bergi* (Aleyrodidæ) as a transmitter of mosaic disease of sugarcane has so far given negative results. Reference has been made in previous reports to a Braconid which is parasitic on the adult weevils of *Myllocerus undecimpustulatus* var. *maculosus* which attacks cotton plants. This has now been determined as a new species of *Dinocampus;* a method of rearing it in captivity has been worked out and its life-history studied.

Fruit tree pests in Baluchistan received special attention and were locally investigated by the First Assistant Entomologist. A new borer of the mango tree from Purneah District was identified as Rhytidodera—a species described from South China which probably exists throughout North-East India and Burma. Among insect pests of the North-West Frontier Province studied is the Apricot Eurytomid which causes much loss as the larvæ live inside the kernel; this could be easily controlled by the systematic collection and burning of fallen kernels. Another is the Green Aphis which causes leaf-curl in peaches. It was found that this could be effectively controlled by spraying with a fluid made from local materials, *viz.*, soap-nut (*Sapindus mukorossi*) fruits and country soap.

The mercury method of preventing insect damage to stored food-grains was further tested. Both free mercury and tin-amalgam are quite effective in preventing insects from breeding in food-grains, can be used in quite small quantities and the trace of mercury vapour which results has no deleterious effect either on the germination of the grain or on its use as food.

In MADRAS, the notorious " fluted scale " insect *Icerya purchasi* was found in the Nilgiris, having apparently come in with imported nursery stock a year or two ago. Arrangements have been made to introduce the parasite, the Vedalia beetle, which has been successfully used to control the pest in other countries. In collaboration with the Entomologist of the Cochin State, the Government Entomologist, Madras, conducted an organised attempt to control the coconut caterpillar. The Pest Act has been put into operation and the caterpillar is being combated by the systematic liberation of natural parasites.

At LYALLPUR special attention was given to the insect pests of cotton ; the life-histories and bionomics of the following were under study :—the spotted boll-worm, cotton stem-borer, cotton semi-looper and the pink boll-worm. Special attention was given to the ' white-fly '. Work on the red cotton bug (*Dysdercus cingulatus*), which is curiously absent in years when the cotton crop is a poor one, showed that the insect only thrives at temperatures between 70° and 95° F. and humidities above 40 per cent.

Preliminary work on two sugarcane pests, *Pyrilla* and the sugarcane white-fly (Aleyrodidæ), showed that both of these insects prefer broad and soft-leaved canes. The use of late-ripening canes or ratooning encourages *Pyrilla* as this sucking insect transfers itself direct from the old to the new crop though it also carries over temporarily on cereals and wild grasses.

XI. Useful Insects.

Lac. The Annual Report of the Indian Lac Association for Research shows that at the Lac Research Institute, Namkum, Ranchi, a well conceived programme of research is in progress ; the entomological and biochemical aspects of the industry have

received due attention whilst new ground has been broken both in the study of the physical characteristics of shellac and of the needs of the principal industries using lac. Shortly after the close of the year under report an important advance was possible as the result of grants made by the Empire Marketing Board and the Government of Bihar and Orissa, which have enabled a technical *liaison* and marketing officer to be appointed in London who will keep the lac-using industries and their specialist research associations in touch with the Namkum Research Institute. The trade in lac is of great importance to India but is threatened by the increasing use of synthetic substitutes. Adequate supplies of lac of reliable quality of the type demanded by the principal users are therefore essential. Improvements are possible both in cultivation and manufacture.

On the entomological side, work has been continued both on the biology of the lac insect itself and on the transference of species to different host plants. Predator enemies of lac and their control have been studied in considerable detail. The most injurious of all the enemies of lac is the moth (*Eublemma amabilis*); this in turn has a number of natural enemies of which the most important are :—*Camponotus compressus*, a black ant which removes the *Eublemma* larvæ; *Bracon tacherdiæ* and *Chalcis tacherdiæ* which feeds on *Eublemma* caterpillars and pupæ and a scavenger of the *Ephestia* species which destroys *Eublemma* larvæ. Another important lac pest is the moth *Holcocera pulveria* the larval stage of which feeds on the lac insect and on stored lac. This also is attacked by *Chalcis tacherdiæ* and certain other insects not fully identified. Of the parasites on the lac insect, three chalcids are important. The study of beneficial insects includes the hyper-parasites of lac parasites and parasites on lac predators.

Artificial control measures under study included fumigation of the collected lac immediately after reaping (except the portion required as ' brood ' lac) and immersing all the collected lac under water for 6-10 days and then drying it in the sun or on hot sand. Lead arsenate sprays have been found useful against predators during the growing season. Pests of the host-plants of lac, mainly

certain scale insects and especially *Aspidiotus* sp., are also being studied. In the experimental plantation the practical problems connected with the growth of lac on different hosts, including methods of cultivation, manuring and pruning of the host trees, have received careful attention. The relative suitability of different hosts for July and February infections is also being studied. The quality of lac produced on different hosts is also receiving careful attention. Papers have also been published dealing with the plant requirement of *Zizyphus jujuba* under cultivation as a lac host and on wax and resin secretion when lac is grown on *Butea frondosa*. The latter investigation shows that (1) a period of accelerated output begins with the fertilization of the female insect; and (2) plots of the host-plant receiving complete manures gave better results than the control plots. Papers have been published on the physical properties, especially the viscosity of lac solutions in different solvents. Mixed solvents promise the best results: this investigation is of practical importance to the varnish-making industry.

XII. Sericulture.

As in the previous year, the BENGAL Agricultural Department maintained 12 nurseries for the production of disease-free "seed" for supply to professional rearers. Sixty-seven selected rearers, mainly ex-students from the sericultural schools, were at work during the year and supplied more seed than the actual Government nurseries; in addition 62 rearers in the Murshidabad demonstration area had their houses properly disinfected and reared seed and cocoons, under the supervision of the departmental demonstration staff, from examined layings of nursery stock seeds. The sericultural staff dealt successfully with a serious outbreak of 'muscardine' disease; in the Murshidabad District 400 cases in 20 villages were reported and 75 per cent. of the crop was saved; in Malda District out of 996 cases, 918 were successfully dealt with, the others being too advanced when reported for preventive measures to be of avail. The selection of Nistari and Chotopolu strains was continued. Experimental feeding tests on Nistari and Chotopolu

strains were carried out with tree-mulberry and bush-mulberry leaves. Manurial experiments to increase the yield of mulberry leaf have given very successful results leading to a considerable reduction in the cost of production. Green-manuring especially has proved a success, whilst the use of fertilizers of the ammonium phosphate type at the end of the monsoon was found definitely to assist the cold weather crop and improve the quality of the leaf.

A further extension of organised demonstrations was a feature of the year's work. Co-operative organisations amongst the silk-rearers are referred to in another chapter.

In MYSORE the four Government *grainages* supplied 8,13,132 disease-free layings, as compared to 6,84,727 layings in the previous year, of which 3,25,778 layings were either hybrids or selected pure races; the demand for the higher-yielding cross-bred layings increased. Selected rearers increased from 132 to 440 during the year and were supplied with 1,65,000 disease-free layings free of cost; they in turn supplied 1,86,00,000 'seed' cocoons which were purchased by Government and aided grainages and private sericulturists; in addition, 32,000 disease-free layings were supplied by the Government grainages to sericulturists in "seed areas" who produced and put on the market about 6 million seed cocoons. The Sericultural Department's staff, in addition to supplying seed-rearers with seed, disinfected their rearing houses free, inspected the silkworms in all stages, dealt with any signs of disease and kept the rearers in touch with purchasers of seed-cocoons.

Aided *grainages* numbered five as compared to two in the previous year and supplied 3,12,080 disease-free layings to 407 persons.

The breeding and hybridisation experiments were continued on previous lines. In addition to maintaining the pure Japanese, pure Chinese and Mysore "fixed" races, twelve new races were introduced during the year and reared experimentally, *viz.*, one Chinese and three European races from Kashmir, two races from Italy and six from Japan.

The cold storage plant was utilised to conduct experiments on the delaying of hatching of eggs of multivoltine races in order to facilitate hybridising, to preserve male moths of pure races and to

" hibernate " eggs of univoltine races received from Kashmir and Japan. It was found that the hatching of multivoltine eggs can be delayed by 16 days, without impairing the health of the silkworms, the optimum temperature being 38° to 40° F.

Experiments in mulberry cultivation included the testing of Kashmir and Japanese varieties, manurial experiments and spraying to eliminate mildew. The Assistant Superintendent visited Italy, France and other European countries to study the latest filature technique. Arrangements for the training of students at the Government filature and local reeling classes were extended. Progress in the co-operative organisation of the silk industry is referred to in a subsequent chapter.

In MADRAS the experiments in rearing univoltine French silkworms at Coonoor were again successful. The hybrids between the French univoltine and the Mysore multivoltine races referred to last year are now in the 17th generation.

As fungoid disease of mulberry still persists at the Coonoor plantation, drainage and cultural experiments have been started with the object of eradicating it and a new farm has been opened at Hosur in order that there may be no check in the supply of disease-free seed.

In BURMA the Maymyo nursery was made definitely experimental and 53 lots of silkworms of different races were reared experimentally during the year, including the established Maymyo hybrid and new crosses with Italian, Baghdad and Chinese races. Nurseries for the supply of seed now exist at Mandalay, Pauk-Kaung (Prome District) and Leiktho (Roman Catholic Mission) in the Toungoo hill tracts. In all 16,290 seed cocoons and 837 layings were supplied. Demonstrations have been started at the Hmawbi, Tatkon and Mudon farms. Manurial experiments on mulberry at Maymyo showed that groundnut-cake and sulphate of ammonia were the most economical fertilizers.

CHAPTER IV.

AGRICULTURAL ENGINEERING.

I. Hydraulics.

As in previous years, the Agricultural Engineering Sections of Provincial Departments of Agriculture have chiefly been occupied with this branch of agricultural engineering—mainly with the better utilisation of underground water-supplies and the improvement of lift irrigation. The enormous scope for such work is obvious from the fact that of the 50 million acres or so irrigated annually in British India, only about 25 million acres is irrigated from canals, the remainder being watered from wells, tanks and other sources; moreover, the area under irrigated cultivation is only about one-fifth of the total area sown. The provision of irrigation facilities not only protects crops against failure or partial failure in years of scanty rainfall, but in a large portion of the country greatly increases the yield even in normal years, thus making possible a higher standard of agriculture. Thus the better utilisation of the smaller local sources of irrigation by the improvement of wells, construction of more efficient types of wells and the improvement of water-lifting appliances for wells, tanks and streams has occupied the attention of agricultural engineers in most Provinces. As is natural, most progress in the better use of underground water-supplies has been made in the Indo-Gangetic plain.

In the UNITED PROVINCES where strainer tube-well construction has been in progress on a large scale for a number of years and where over 200 large tube wells suitable for power pumping plant and over 200 smaller ones have been installed for private individuals, the position has been carefully reviewed and a considerable re-organisation of the Agricultural Engineering Section undertaken. In addition to the preparation of detailed projects which include estimates of running charges as well as of capital cost, actual tests of each strainer are now undertaken before the pumping plant is selected. These tests include the accurate measurement of the

discharge of the tube and of the depression in water-level during pumping, so that suitable pumping machinery may be selected which will utilise the water-supply fully but will not permit of an undue depression of the water-level and would endanger the future stability of the well. From these tests a schedule of running charges is prepared so that the owner is in a position to know what his water will cost him per acre and to plan his agricultural operations accordingly. The results have been published of tests on 60 of the 71 tube-wells which were completed and tested during the year and of the more detailed tests and schedules of running charges for 21 of the larger installations. The best discharge obtained was 35,640 gallons per hour excluding three quite small installations, running costs (including 15 per cent. on capital for interest and depreciation and based on a working year of 1,800 hours) ranged from 12 annas to about Rs. 2-8 per acre-inch of water. These figures clearly bring out the fact that, except when the lift is small, such installations are only profitable when an intensive system of agriculture, including valuable crops like sugarcane and tobacco, is adopted. Of the 71 tube-wells referred to above, 44 were of small sizes for use with bullock power, the cost varying from Rs. 39 to Rs. 884 and the discharges from 400 to 3,700 gallons per hour. Many of these should clearly be profitable to their owners.

In the PUNJAB the feature of the year was the increased popularity of stoneware strainers for tube-wells, 519 of which were installed. The special advantages of the strainer are that its cost is only half of that of the next cheapest type on the market and it is immune from the electro-chemical deposits of the silica which, by choking up the interstices, has rendered many metallic strainers ineffective in certain areas. The usual size of stoneware strainer is $3\frac{1}{2}''$ diameter, and it has mainly been used for wells to be worked by Persian wheels or other forms of bullock-power water-lift.

In BIHAR AND ORISSA nineteen strainer tube-wells were constructed during the year and five were in progress of construction, applications for 18 more having been received. The equipment of the Agricultural Engineering Section was improved by additions to the staff of borers, the supply of more large size boring plant and

the purchase of suitable air-lift pumps for testing the discharge of bores.

In BENGAL the appointment of an Agricultural Engineer has enabled the study of irrigation questions to be taken up. Two tube-wells with engines and pumps were installed on the Dacca and Nadia farms respectively.

II. Well-Boring.

In most Provinces the Agricultural Departments continued to maintain a staff for the improvement of village wells by boring and for trial bores in connection with the construction of new masonry wells for irrigation and general agricultural purposes. In the UNITED PROVINCES this section of the department's work also was re-organised and better arrangements made for the supervision of district borers. During the year 1,552 wells were bored of which 1,227 (79 per cent.) were successful compared to 999 with 74 per cent. successful in the previous year. The system of carrying out recuperation tests on each well both before and after boring has been adopted in order that a definite measure of the improvement effected may be available. This system is already in practice in the PUNJAB where no boring is reported as successful unless the supply is increased by at least 20 per cent. In the latter province 966 wells were bored as compared to 725 in the previous year. The percentage of successful bores fell from 83·8 to 80 per cent. due to more work being undertaken in areas where geological conditions were unfavourable. The number of feet bored was 82,727 feet compared to 68,984 in the previous year. An artesian bore yielding 5,000 gallons per hour in Rawalpindi District and a sub-artesian bore at Pindigheb in which water rose 16 feet and to within 2 feet of the surface, were completed during the year.

In BIHAR AND ORISSA 303 borings were made of which 268 were successful. A system of recording all bored wells on maps was adopted in order that these wells may be visited by boring supervisors in the course of their tours and a report made on whether the improvement has been maintained or arrangements made to clear choked bores where necessary. Proposals were made for the

purchase of a small rock-drilling plant to investigate possibilities in the Chota Nagpur Division and certain adjoining areas.

In BOMBAY 254 bores were carried out. Of 213 completed during the year, 136 were successful, resulting in the tapping of 95,011 gollons of water per hour. Many of these wells are required for general water-supply rather than for irrigation, and in the Deccan and Dharwar Circles boring has been carried out under very difficult conditions. It is estimated that the boring operations of the last 20 years have covered 1,87,410 feet of boring and added 30,22,886 gallons per hour to the water-supply of the Presidency. Four water-finding machines were worked on 413 sites for the public and 105 sites located where underground water might be expected. Information of the result of digging wells at selected sites has however only been received for 10 sites, on 8 of which the wells were successful and in 2 cases success was doubtful.

In MADRAS the Industrial Engineer's Section of the Industries Department maintained 20 power drills and 96 hand-power boring plants and carried out 746 well-borings, 473 of wich were successful, the total depth bored being 40,672 feet compared to 843 bores and 43,171 feet in the previous year. Seven artesian bores, six of which were in the South Arcot District, were made. One of these, which from a depth of 263 feet gave a steady supply of 420 gallons per minute rising to 20 feet above ground-level, is probably the largest artesian supply in India. A subsoil water survey of the Bellary District was partly completed.

III. Lift irrigation and Water-lifts.

The installation of the larger size tube-wells already referred to involved the provision of suitable power pumping plant. The development of power pumping for irrigation from other sources has received attention.

In the PUNJAB lift irrigation forms a special Division of the Agricultural Engineer's Section under the charge of an Executive Engineer. The Division deals primarily with the investigation of the possibility of irrigating areas uncommanded by canal irrigation and with schemes for lifting from tube-wells. Five projects

dealing with areas varying from 3,600 to 20,000 acres have been worked out; these contemplate electrically driven pumps on the individual tube-wells. The cost of irrigation per acre per crop has been calculated at Rs. 25 for the smallest and Rs. 19 for the largest of these projects. Two other projects have been prepared for developing areas of 8,500 and 18,000 acres using the power available from neighbouring canal falls; here water could be supplied at Rs. 13 and Rs. 11 per acre per crop respectively; these rates were acceptable to the land-owners and tenants. The Division also prepared tube-well and minor irrigation projects for a number of private land-owners.

In MADRAS the Industrial Engineer erected 51 power pumping plants, bringing 827 acres of land under irrigation; 307 power pumping plants were inspected by his staff under the Industrial Department's maintenance scheme under which the owner pays Rs. 10 per annum for three inspections.

In BIHAR AND ORISSA a pumping installation on the Mahwa Bund delivering 90,000 gallons per hour at a head of 16 feet was completed during the year: this is the first installation of its kind in the Province and at a capital cost of about Rs. 6,000 has brought 600 acres under irrigated cultivation. In South Bhagalpur two portable pumping sets working on small streams—one irrigating six acres per day with a lift of 18 feet and one irrigating three acres per day on a 15-feet lift were installed and worked satisfactorily: the former set was installed for the Central Co-operative Bank.

In BOMBAY, the Agricultural Engineer dealt with 42 enquiries for pumping plants.

IV. Improved Water-lifts for Bullock-power.

Of these, the improved Persian wheel (*rahat*) made of metal received most attention and a number of patterns of fairly satisfactory design are now being made by local firms in various parts of the country. For most of these it may fairly be claimed that not only has the strain on the bullock been reduced but the depth at which the Persian wheel is economic has been increased. The Agricultural Engineer, PUNJAB, carried out a number of efficiency

tests on different patterns at Lyallpur (using a specially designed " electric bullock " to supply measured energy) and found as a result that the efficiency of different models varied from 66 to 72 per cent. The Punjab Ministry of Agriculture offered for competition in 1930 a prize of Rs. 2,000 for an improved design for a Persian wheel, cost not to exceed Rs. 175. The Tata Iron and Steel Company have offered a subsidiary prize of Rs. 500 for an improved Persian wheel of sufficient merit which can be constructed of steel sections such as the Company can produce.

In BIHAR AND ORISSA a temporary failure of the late monsoon rains stimulated the demand for the Agricultural Department's improved *rahat*, of which 100 were issued in a few weeks by the Agricultural Engineer with the co-operation of small local firms.

V. Embankments and Channels.

Both in the prevention and checking of erosion, in the carrying out of small irrigation projects and in economical distribution of water, the Agricultural Departments can render material assistance to the agriculturist by the loan of surveying staff who can take levels and design simple works. The Poona method of embanking and terracing was commended by the Royal Commission on Agriculture and the special staff maintained to assist agriculturists in the correct designing and siting of *bunds* and waste weirs has now seen 54 schemes completed all of which were inspected during the year. Plans and estimates for 32 schemes in 21 villages in Bijapur District were prepared and 22 schemes framed for the reclamation of small *nala* beds. Schemes costing over Rs. 500 are mainly financed by *taqavi* loans but some by co-operative societies. A special class for cultivators with the object of teaching the principles of *bund* construction was held during the year.

In the Chota Nagpur Division of BIHAR AND ORISSA, the Kanke system of contour *bunds* to check erosion, regulate run-off and protect the rice land below the *bund* has proved a success and a small staff is employed in preparing schemes for agriculturists and supervising construction. In South Bihar, where small privately-owned irrigation works are fairly numerous and of great importance

to rice-growers, the Agricultural Engineer's Section inspected and surveyed 32 embankment and drainage schemes and work was started on seventeen.

In the UNITED PROVINCES each Agricultural Engineering Circle is provided with a sub-overseer to take levels and ' peg out ' irrigation channels for the owners of tube-wells.

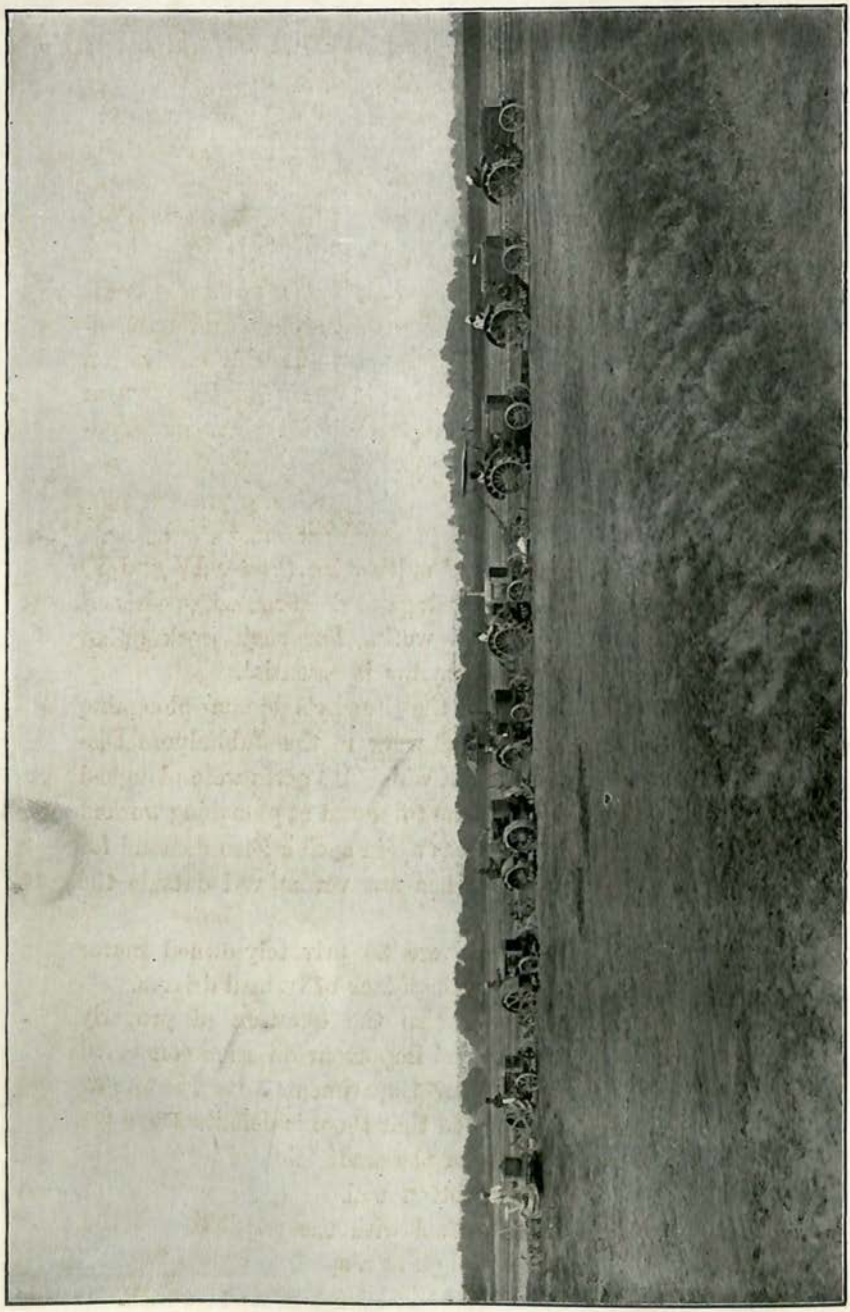
VI. Agricultural Machinery.

Next to water-lifts the use of small oil-engines for cane-crushing is perhaps the most important development at present. In BOMBAY, though the area under cane is relatively small, 57 power cane-crushing mills are in use in the Deccan canal area. The use of miscellaneous power-driven agricultural machinery is increasing and in each Division a mechanical assistant is employed to assist agriculturists in the erection and maintenance of engines and machines.

In the UNITED PROVINCES, BIHAR AND ORISSA and BENGAL special attention was paid to small power-driven sugarcane-crushers the use of which is steadily extending. At present there is no small power-driven cane-crushers on the market which gives as good an extraction as a well-adjusted three-roller bullock cane-mill, but the limited capacity of the latter is a serious handicap, and with the spread of new high-yielding varieties of cane, power-crushers are essential in many cane areas. Progress has also been made in the design of agricultural implements. The Bihar plough, cultivator and ridging plough designed by Mr. Cliff, have proved to be a valuable set of implements for North Bihar ; demonstration on a considerable scale was organised and manufacture and sale has been taken up by two local engineering firms. As these implements are so designed as to give the ploughman full control over his bullocks as well as being light and cheap, they will probably be found of use in other parts of Northern India.

In MADRAS an improved *guntaka* or blade-harrow was standardised and is now manufactured in three sizes. A Research Engineer was appointed to the Agricultural Department during the year and has taken up the design of seed-drills and the testing of

PLATE IV.



Tractor Demonstration at the Imperial Institute of Agricultural Research, Pusa.

PLATE V.



Tractor Ploughing at the Imperial Institute of Agricultural Research, Pusa.

different types of ploughs now on the market in India for suitability to different types of soils and for wearing qualities.

In BOMBAY the Agricultural Engineer effected further improvement in the design of his new seed-drill and arrangements for its manufacture by a firm are contemplated. A new winnower was successfully completed: this can deal with 1,000 lbs. of threshed *juar* per hour at a cost of 5 annas.

In BURMA, with the appointment of an Agricultural Engineer, the question of improvements in indigenous implements has again been taken up; methods of reducing the cost of paddy cultivation is the first problem undertaken. The improved plough known as the *Theikpan* plough, designed by the previous Agricultural Engineer, continues to be in demand.

VII. Mechanical cultivation.

In several Provinces mechanical cultivation (Plates IV and V) has a definite future for the eradication of deep-rooted weeds and grasses amounting to reclamation work. For such work either steam-tackle or a high-powered tractor is essential.

In the CENTRAL PROVINCES, the Fowler's steam ploughing tackle (double-engine set) did good work in the Jubbulpore District, reclaiming 574 acres of land, of which 416 acres were ploughed between November and March. The total cost of ploughing worked out as Rs. 15 per acre and there was again such a keen demand for the services of the tackle that it has not yet moved outside the Jubbulpore District.

In the Berar Division there were 38 privately-owned motor tractors, but 10 were laid aside through lack of trained drivers.

In the BOMBAY PRESIDENCY also the question of properly trained drivers seems to be the most important question connected with the use of tractors at present. Experiments with tractors at the Babbur farm in MYSORE showed that there is definite scope for the use of high-powered tractors for the eradication of *hariali* grass (*Cynodon dactylon*) from black cotton soil.

The above references mainly deal with the possibility of the steam-plough or tractor-drawn plough as a special purpose tool.

In BURMA the possibilities of the tractor under general farming conditions are now being investigated and the use of tractors for paddy cultivation studied. Already there is a mild boom, 49 tractors having been sold during the year for use on the flooded areas along the Irrawaddy. These areas have the advantage of being workable during the hot weather months but are badly infested with *kaing* grass. By tractor cultivation, the paddy crop, usually a flood-resistant variety sown without bunds, gets a better chance and a larger area can be cultivated in time for sowing.

VIII. Steam Threshing.

In an experiment at the Agricultural College Farm, Cawnpore, a steam threshing set driven by a tractor and giving an outturn of 158 maunds per day, threshed and winnowed wheat at $7\frac{3}{4}$ annas per maund including allowance for depreciation and interest, as compared to Re. 1 per maund for threshing when the grain is trodden out by bullocks and winnowed by hand if bullocks are charged at Rs. 2-2 per pair per day.



CHAPTER V.

LIVESTOCK.

(1) Prevention and Treatment of Disease.

GENERAL REVIEW.

The year under review saw the completion of the separation of Provincial Veterinary Services from Agricultural Departments, in accordance with the recommendation of the Royal Commission on Agriculture in India, and Directors of Civil Veterinary Departments now have direct access to Provincial Governments in most Provinces, a facility which should lead to greater expedition of business and a better understanding of the problems to be faced by Provincial Veterinary Services.

These Services are however greatly handicapped by shortage of fully trained personnel and by the want of adequate accommodation and facilities for some of the work for which they are responsible. In most Provinces the hospitals and dispensaries are still far too few, and in many instances the buildings provided are old and unsuitable for their purpose, while Veterinary Laboratories, suitably staffed and equipped for bacteriological diagnosis and systematic investigation of disease, can hardly be said to exist at all in some Provinces. Large and expensive laboratories are not required for this work, nor the teams of workers necessary for fundamental research, but suitable laboratory accommodation and staff for the investigation of local disease-producing factors are essential to efficiency in every progressive State or Province.

The cost of the necessary provision would be very small compared with the benefit to be derived therefrom, and such expenditure is the more necessary in India because there are no veterinary surgeons available in private practice, and the Provincial Veterinary Services are the only source to which stock-owners can turn for veterinary aid or advice.

Moreover, the major contagious diseases of stock are for ever changing in distribution, type and severity, and precise knowledge of local disease conditions can only be acquired by constant and systematic investigation.

Economic Importance of Veterinary Aid.

There are no exact figures available as to the total number of domesticated animals for which the Veterinary Services are responsible, but there were over 150 million bovines in British India at the last census, while the total cost of the entire Veterinary Services of British India, for the year 1928-29, including research and serum production, amounted to less than sixty-six lakhs of rupees. Against this total, receipts amounting to 21½ lakhs were obtained during the year, but the provincial receipts could be materially increased if adequate charges were made at all veterinary hospitals and dispensaries for the treatment of individual cases of illness and injury among privately owned animals.

No Government is called upon to provide free treatment for such cases, and if any surplus receipts obtained from this source were spent on the provision of adequate veterinary services for the control of contagious disease and for the improvement and maintenance in health of farm animals, the work would be of considerable indirect benefit to the live-stock industries of India.

The net cost of the entire Veterinary Services, including veterinary education and veterinary research, in British India, thus amounted to less than 45 lakhs, which is an extremely low insurance rate on the total value of the stock for which those services are responsible, while the saving effected by protective inoculation alone, during the year under review, is estimated at crores of rupees. This total might moreover have been greatly exceeded had more veterinary staff been available, while greater attention could have been paid to other less obvious but economically no less important disease conditions, such as those due to the protozoa and to worm infestations, the general ill-health and stunted development caused by which is at present an extremely heavy tax on the agricultural industry.

Number of Cases Treated.

The number of cases treated by Veterinary Assistant Surgeons, during the year, in hospitals and dispensaries and on tour, was 3,411,932, a decrease of 14,904, while the castrations amounted to 510,899, an increase of 102,503, compared with the figures for the previous year. The decrease in the number of cases treated was mainly due to the preoccupation of Provincial Veterinary Services with rinderpest control, and it is a cause for satisfaction that there was no falling off in castration which, for humanitarian reasons as well as in the interests of stock improvement, should be carried out by Provincial and State Veterinary Services to the fullest possible extent.

Disease Control.

Control of contagious disease is, however, the main task of these Veterinary Services, and though progress in such control must be slow, it should be continuous. The only path by which progress is possible is that leading to better education of the public to a higher standard of animal husbandry, and a more adequate veterinary organization, able to obtain early and accurate information of disease as it occurs, and to adapt every advance of scientific knowledge to the particular circumstances of the widely different areas met with in this country.

Though local problems vary, the most fatal contagious diseases of stock are the same throughout, and these can only be effectively dealt with by concerted action, covering the whole or so much of India as the circumstances of the case demand. For such action since contagious disease has no respect for political boundaries, early information of outbreaks, wherever they occur, and all-India legislation for the control of movement, are obviously essential.

During the year under review, contagious disease of stock was exceptionally severe and wide-spread throughout the greater part of India, rinderpest and foot-and-mouth disease were both very prevalent, and the former was of an unusually virulent type in Madras, Burma, Sind, Central Provinces, and Bihar and Orissa.

The mortality from hæmorrhagic septicæmia and blackquarter was also unusually high in nearly every Province. This was apparently due, some extent, to the inability of Provincial Veterinary Services, already fully employed in dealing with outbreaks of rinderpest, to give the immediate attention required for the effective control of these diseases.

Mortality.

The total recorded motality from contagious disease of all kinds, among domesticated animals of every sort, was 371,816, an increase of 60,594 compared with that recorded during the previous year.

Rinderpest, as usual, was the principal cause of loss from the major epizootics, and was responsible for 63·8 per cent. of the total recorded mortality from contagious disease among bovines. It appeared in every Province and was particularly severe and widespread in Madras and Burma.

Spread of disease.

In the former, and in the Central Provinces, the usual annual movement of dealers' cattle, from fair to fair, is considered to have been very largely responsible for spreading this disease, while it is stated that in Mysore State numerous outbreaks were definitely traced to this source.

The same cause must operate in the spread of foot-and-mouth disease, the economic loss from which, though often not thoroughly realized, is a cause of heavy loss to stock-owners.

If the spread of such diseases is to be checked some control of movement is essential but for a country such as India, where control must always be difficult, every effort should be made to perfect sanitary, and medicinal, methods of prevention and treatment.

In Madras the system of mortality registration inaugurated some years ago is said to be working satisfactorily but, generally speaking, the recording and notification of disease is anything but complete and there is little doubt that a very great deal of the mortality which occurs, all over India, is never reported at all.

Effective control measures are impossible unless precise information of mortality is promptly supplied to the Veterinary Services, and this is a matter regarding which legislation and educative propaganda are very necessary.

IMPORTANCE OF PARASITIC DISEASE.

Owing to the steady extension of irrigation to dry areas some of which, until recently, maintained the best breeds of Indian cattle, the systematic study of parasitic diseases, all over India, is another matter of great and ever increasing importance.

To mention only a few of the most common diseases met with in water-logged and swampy areas and on land subject to seasonal flooding, it may safely be said that the gross economic loss caused throughout India, year by year, by parasitic worm infestation, hæmorrhagic septicæmia, surra, and coccidiosis, though not so obvious, probably far exceeds that caused by rinderpest.

The mortality from these diseases, particularly hæmorrhagic septicæmia and surra, is heavy, but the indirect financial loss caused by the stunted development and nutritional inefficiency due to parasitic worm infestations and coccidiosis must be far greater, owing to the waste which occurs in feeding such animals.

For hæmorrhagic septicæmia and surra satisfactory methods of control are now available, and are being applied as far as the limited staffs at the disposal of Directors of Veterinary Services will permit, but further local investigation of the practical application of these methods is required, while it has hardly been possible to attempt to control parasitic infestations, owing to the magnitude of the task and the want of adequate expert staff and facilities.

The control of blood diseases due to the protozoa, by tick destruction and medicinal treatment, is another matter of great economic importance which requires to be dealt with on a big scale. Thorough investigation of contagious abortion, tuberculosis and Johne's disease, each of which is of considerable economic importance in India, is also urgently necessary. Recent observations show that the last named disease is spreading rapidly in dairy herds

in this country, while the two former are increasing in incidence and, being communicable to man, are of importance from the public health point of view.

The Economics of disease control.

Compared with the annual economic loss now caused by such conditions the extra cost of control work would be negligible, but it has even been seriously contended that it is of no use spending money on investigation of diseases of stock in India, because there are already too many cattle, and that it would be better to let some of them die, and to use all the money available in providing more food for the survivors. If such an idea should gain wide acceptance, there would be small hope of accomplishing anything effective to help the live-stock industries of India. It seems necessary therefore to point out that, apart from the waste which would be entailed in maintaining the dams of the young stock which die, it can hardly be contended that it is sound to use up a large proportion of the very inadequate supply of food available in feeding animals which are unable to make economical use of their food, and which are constantly contaminating grazing areas with more and more parasites.

To keep such animals is obviously injurious to the live-stock industry of the whole community, and as they cannot be destroyed, active measures should be taken to maintain them in health.

Systematic investigation of stock disease, on the other hand, has proved itself a profitable investment in all progressive stock-raising communities, the expense being amply repaid in the savings effected.

The cost of feeding cattle, particularly in the irrigated areas and for dairy purposes, amounts, at the lowest computation, to a considerable sum per head, each month, while the total net cost of the entire Veterinary Services of British India, including veterinary research, during the year under review, would have amounted to an annual expenditure of less than half an anna per head, if divided among the 150 million cattle enumerated in the last census, all other animals being left out of consideration.

The amount which could be made available for the feeding of animals by totally abolishing the Veterinary Services of India would therefore, be entirely negligible, while the annual saving now effected by inoculation alone far exceeds the total cost of veterinary aid.

To devise practicable methods of providing an adequate reserve of forage for periods of scarcity, and of making the best possible use of the supply available, is without question the most important problem to be faced by the live-stock industries of India, but the financial and other difficulties are immense.

Meanwhile veterinary aid, to prevent disease and degeneration, is the only method which is capable of producing tangible results without heavy recurring expenditure.

If the present numbers of cattle are not required, and this is admitted, everything possible should be done to reduce the numbers bred and to improve the efficiency of the remainder.

The cost of maintaining old and inferior animals, owing to religious objection to their slaughter, is already a far heavier tax on the live-stock industry than that imposed by any Government, and is apparently unavoidable, but the waste which at present occurs in maintaining chronically diseased animals, which are a danger to their fellows, ought not to be permitted to continue unchecked.

(2) Protective Inoculation and Treatment.

During the year, 6,588 outbreaks of rinderpest were attended to and 997,752 animals were protected, either by serum-alone or by the serum-simultaneous method.

In addition, the following were inoculated against other diseases, *viz.*, hæmorrhagic septicæmia 749,149, blackquarter 134,750, and anthrax 17,402, making a grand total of 1,899,428 protective inoculations during the year, an increase of 172,373 compared with the figure for the previous year.

To carry out this number of inoculations, with their existing establishments, has taxed Provincial Veterinary Services highly but the objection to inoculation which formerly existed is reported

to be dying out and more could have been done had more personnel been available.

This remark applies particularly to the serum-simultaneous method of inoculation against rinderpest, which is stated to be very popular in the localities where it has been employed in previous outbreaks, and it is to be hoped that every opportunity will be taken of popularising this method, which has manifest advantages for India where, under existing circumstances, effective quarantine is not practicable.

The high cost of protective biological products is, however, undoubtedly a bar to their more extensive use, and Provinces protest their inability to increase expenditure in this respect. Steps are consequently being taken, in accordance with the recommendation of the Royal Commission on Agriculture in India, to separate the cost of research from production, in the hope that it may be possible to reduce the price in future.

For the control of foot-and-mouth disease, reliance has still to be placed on sanitary and medicinal measures to localise outbreaks and to reduce the severity of attacks. Any attempt to stamp out such an extremely contagious disease under Indian conditions would be foredoomed to failure, but power to control movement and quarantine infected herds will be necessary if spread of such highly contagious disease is ever to be kept in check.

During the year, attempts were made to put regulations for the control of movement in force in certain areas in Madras and Burma but legislation for the whole of India and more prompt notification will be required before much can be done to check outbreaks at their inception.

Reduction of mortality by protective inoculation must consequently continue to be the sheet anchor of rinderpest control and, in view of the much more durable immunity conferred by the serum-simultaneous method, this system of inoculation should have preference wherever conditions permit of its application. A total of 84,489 cattle were protected by this method in British India during the year under review and records show that the total mortality among these animals, after inoculation, amounted

to 303 or 0·35 per cent., while the mortality among 912,908 cattle protected by serum-alone amounted to 3,997 or 0·43 per cent.

For imported cattle, which are highly susceptible, the serum-simultaneous inoculation should certainly be employed, and the use of goat virus has been recommended for such cattle, because of the reduced severity of the reaction produced and the freedom of this virus from piroplasms.

Particularly careful observation is however essential in applying this method to insure that the virus used in the field shall be of full virulence.

For the protection of indigenous cattle, the majority of which are apparently already infected with piroplasms, virus obtained from cattle and buffaloes is however still employed, Trypanblue being used to control intercurrent attacks of fever due to *Piroplasma bigeminum*. In Madras, 82,925 cattle were protected by this method during the year, and it has been found that a very satisfactory virus can be maintained indefinitely, by passage through indigenous plains cattle and buffaloes alternately.

The recorded figures show that the results of this method of inoculation are highly satisfactory, but local investigation is nevertheless necessary, to study its application in the field, to cattle whose susceptibility varies in almost every Province.

(3) Disease Control in the Provinces.

Madras. The recorded mortality from contagious disease during the year was 170,936, rinderpest alone being responsible for 129,583 deaths. The principal causes of death among bovines were rinderpest, anthrax, blackquarter, hæmorrhagic septicæmia and foot-and-mouth disease. Rinderpest raged in an epizootic form in most parts of the Presidency and was dealt with mainly by the serum-simultaneous inoculation; virus produced locally, by alternate passage through plains cattle and buffaloes, being successfully employed. There was also an appreciable increase in mortality from hæmorrhagic septicæmia, anthrax, blackquarter, and foot-and-mouth disease, while tuberculosis was detected among

Madras Corporation animals and was observed, for the first time, to affect fowls in the Presidency.

Considerable amount of local investigation, diagnostic bacteriological work, and collection of pathological specimens, was carried out at the Madras College, and propaganda of educative value in veterinary matters was organized.

The system of cattle mortality registers and of reporting outbreaks of disease, now in force, is reported to be working more satisfactorily and should be of increasing value to the Provincial Veterinary Service, as time goes on.

Bombay. The recorded mortality from contagious disease during the year was 15,835. Deaths were mainly due to black-quarter, rinderpest and hæmorrhagic septicæmia, all of which were very prevalent. The mortality from anthrax and surra, on the other hand, was much reduced. The so-called Dengue disease caused 55 deaths among cattle, goat scab was responsible for 155 deaths among sheep and goats, and 25 cases of rabies in dogs were confirmed, out of 46 examined.

One thousand one hundred and thirty-nine specimens were examined bacteriologically, and the treatment of surra by injections of Bayer 205 was successfully carried out at the Bombay Veterinary College Laboratory, during the year, but there is no trained investigation staff on the establishment of the Provincial Veterinary Service.

Bengal. The total recorded mortality from contagious disease during the year was 13,848. The principal causes of death were rinderpest, hæmorrhagic septicæmia, foot-and-mouth disease, and anthrax among bovines, surra among equines, and distemper, rabies, and fowl cholera among other animals.

A severe outbreak of surra occurred among hack ponies in Chittagong and a large number of deaths were reported among poultry from 'Avian Distemper,' which was very prevalent in the Eastern and Northern parts of the Province. Wild birds were also affected by this disease which, according to recent investigations at Muktesar, appears to be the same as the so-called 'Ranikhet' or "Newcastle" disease of fowls.

The year was however a comparatively healthy one for live-stock in this Province, and the total recorded mortality from contagious disease was appreciably reduced. Rinderpest, as usual, was the most serious epizootic disease and accounted for 67 per cent. of the deaths reported among bovines. The mortality from hæmorrhagic septicæmia was greater than during the previous year, and the necessity for local investigation of this disease has been drawn attention to by the Director of Veterinary Services.

Funds were made available during the year for the purchase of magic lanterns and apparatus for propaganda purposes, and the Veterinary Department again took part in the tour of various parts of the Province by a Demonstration Train.

Some diagnostic bacteriological work was carried out at the Bengal Veterinary College, but it is essential that the Director, Civil Veterinary Department, shall have suitably trained veterinary personnel at his disposal, for the diagnosis and investigation of disease wherever it may occur.

Bihar and Orissa. The total recorded mortality from contagious disease was 27,894, the principal causes of death being hæmorrhagic septicæmia, blackquarter, and rinderpest among bovines, and rabies among other animals.

The incidence of both foot-and-mouth disease and rinderpest was much reduced, but the mortality from hæmorrhagic septicæmia was considerably greater, while that from blackquarter and anthrax was less than during the previous year.

There was a considerable increase in the number of preventive inoculations carried out during the year, in spite of the limited staff available and the reluctance of certain District Boards to bear the full cost of the necessary biological products.

An all-round increase took place in the numbers of cases treated by Veterinary Assistant Surgeons and in castrations, and a small increase of staff was made, but more is urgently required, particularly in Orissa.

A large amount of diagnostic bacteriological work was carried out during the year and with the establishment of the new Veterinary College at Patna, the buildings for which are now complete,

better facilities for systematic disease investigation will be available in the near future.

United Provinces. The total recorded mortality from contagious disease during the year was 26,093. The principal causes of death, among bovines, were rinderpest, hæmorrhagic septicæmia, foot-and-mouth disease, blackquarter, and anthrax, while distemper, rabies, and fowl cholera caused the heaviest mortality among other animals.

The reduction in mortality from contagious disease is attributed largely to the increasing popularity of inoculation for the control of epizootics. Foot-and-mouth disease was very prevalent but mortality was reduced by hygienic and curative measures, where it was possible to apply them. Hæmorrhagic septicæmia was prevalent throughout the greater part of the Province and assumed a severe form in many districts. Blackquarter was also very prevalent and mortality from this disease was much increased, while anthrax caused approximately the same number of deaths as during the previous year.

The number of veterinary hospitals and dispensaries was slightly increased during the year but the necessity for more of these institutions and more well trained staff is badly felt.

Small laboratories exist at Circle Superintendents' headquarters and a considerable amount of diagnostic work was carried out during the year, but there is no trained staff on the establishment for the systematic local investigation of disease.

Propaganda work, to educate village officials and ryots in the better care of live-stock, was carried out by means of lectures and exhibits at fairs and shows throughout the Province, and is reported to be doing good.

The necessity for legislation in connection with control of contagious disease, and further action for the control of diseases communicable to man, such as rabies and tuberculosis, is drawn attention to in the annual report of the Director, Veterinary Services, of this Province.

Punjab. The total recorded mortality from contagious disease during the year was 29,146. The principal causes of death were

rinderpest, hæmorrhagic septicæmia, foot-and-mouth disease and blackquarter among bovines, and rinderpest and hæmorrhagic septicæmia among other animals.

Rinderpest was prevalent in nearly every district of the Punjab but the mortality was considerably reduced. The death rate from foot-and-mouth disease and hæmorrhagic septicæmia was also somewhat reduced but the latter disease is said to be undoubtedly spreading in this Province, owing to the extension of irrigation and consequent increase of water-logged areas.

The same remark applies to parasitic diseases and this is a matter in regard to which constant vigilance and local investigation are necessary. Diseases of this class cause very heavy financial loss to the Punjab every year, owing to loss of condition and stunted development of young stock, apart from actual mortality and to the waste entailed in feeding animals which are unable to make full use of the forage consumed owing to their parasitic infestation. The mortality from surra on the other hand has rapidly decreased during the past three years, owing to the improved methods of treatment which are now being extensively employed in this Province, at special surra-treatment centres.

The total number of protective inoculations carried out during the year was considerably greater than during the previous year, but is still hardly sufficient to influence mortality to a marked extent throughout the Province. The serum-simultaneous method of inoculation, against rinderpest, is only employed in special cases, and local investigation of this method is urgently required in order that its use can be safely extended on a large scale.

Earlier and more precise information of outbreaks is reported to be still very difficult to obtain, but a disease investigation officer was appointed to the staff of the Director of Veterinary Services during the year, while much valuable diagnostic bacteriological and local research work was carried out and specimens of parasites, models, and other materials were supplied for use in the Demonstration Train by the Lahore Veterinary College.

Burma. The total recorded mortality from contagious disease during the year was 25,639, the principal causes of death being

rinderpest, foot-and-mouth disease, and anthrax among bovines, and surra among equines.

Contagious disease in this Province is said to be largely imported from the territory to the North and to be enzootic among big game in certain areas.

Quarantine measures for the control of such disease are applied, but difficulty is experienced in controlling movement across the frontier from China. Arrangements are being made for the introduction of the serum-simultaneous method of inoculation against rinderpest, and for the establishment of a serum institute in the Province for the production of biological products, as, owing to the length of time occupied in transit, these products cannot be satisfactorily supplied from the Muktesar Institute.

This Province has a fully trained Research Officer on the establishment of the Veterinary Service and a great deal of valuable research and local investigation work was carried out during the year.

Central Provinces. The total recorded mortality from contagious disease during the year was 28,690. The year was an unhealthy one for cattle and the mortality showed an increase of 37 per cent. over that recorded during the previous year. Rinderpest was prevalent throughout the Province and was markedly virulent in certain divisions. Foot-and-mouth disease, though prevalent, assumed a milder form, but a marked increase occurred in the mortality from blackquarter, and hæmorrhagic septicæmia was also very prevalent, while anthrax caused a large number of deaths.

The rapid spread of contagious disease in this Province is attributed to the annual movement of large numbers of cattle, from the North to the South-East, and to their congregation at the numerous cattle fairs *en route*.

Microscopical diagnosis of disease is carried out on a large scale, and a large number of specimens were examined, but a thoroughly trained disease investigation staff is urgently required in this Province, where there is no Veterinary College and where local investigation of a number of diseases is particularly necessary.

Energetic and successful action was taken during the year to check the spread of disease from certain affected areas. In the absence of powers to control movement over wide tracts of country, it was necessary however to denude other parts of the Province of their veterinary staff in order to accomplish anything effective.

In spite of this interference with their normal duties, large numbers of preventive inoculations and castrations were carried out by the subordinate staff, and these are steadily increasing.

The gradual introduction of the serum simultaneous method of inoculation against rinderpest is under consideration, and is to be particularly recommended for this Province, in view of its situation in the track of the annual movement of cattle previously mentioned.

Assam. The total recorded mortality from contagious disease during the year under report amounted to 20,478. The principal causes of death were rinderpest, hæmorrhagic septicæmia, foot-and-mouth disease, and anthrax among bovines, surra among equines, and distemper and canine typhus among other animals.

The reduction in total mortality was mainly due to a heavy reduction in the deaths from rinderpest and foot-and-mouth disease. The mortality from hæmorrhagic septicæmia, anthrax, and surra, on the other hand, was increased, and the necessity for systematic investigation of outbreaks with a view to the more effective control of these diseases has been drawn attention to by the Director of Veterinary Services.

Efforts were made during the year to increase the number of castrations, but it is said to be difficult to arouse any enthusiam, because little interest is taken by cultivators in their stock.

A large number of elephants examined were found to be infected with entozoal parasites, and observations on drug treatment for these parasites are being carried out.

Sind. The total recorded mortality from contagious disease during the year was 6,824. The principal causes of death were rinderpest, hæmorrhagic septicæmia, and liver-fluke disease among bovines, surra among equines, and contagious pleuro-pneumonia and rabies among other animals.

Contagious disease occurred in every district, and the increase in total recorded mortality was mainly due to rinderpest, which appeared in all districts except Thar-Parkar. Foot-and-mouth disease was also very widespread but the mortality was reduced. Hæmorrhagic septicæmia was reported from all districts and the mortality was considerably increased. Liver-fluke disease was very prevalent in Karachi District and caused a large number of deaths. Mange was very prevalent among camels, dogs and sheep and 38 animals died or were destroyed on account of rabies.

The staff and facilities at the disposal of the Superintendent, Civil Veterinary Department, are very inadequate for the area he is responsible for and should be considerably increased particularly in view of the increase in the irrigated area now taking place.

Rajputana. The total recorded mortality from contagious disease during the year was 264. The principal causes of death were rinderpest, blackquarter, and equine surra.

Rinderpest was prevalent in the Ajmer district but mortality from surra among horses during the year was reduced. Foot-and-mouth disease was prevalent in the Ajmer district and a very severe outbreak of blackquarter occurred in this area.

Baluchistan. The total recorded mortality from contagious disease during the year was 3,059. The principal causes of death were rinderpest, goat and sheep scab, anthrax, liver-fluke disease, contagious pleuro-pneumonia and sheep pox.

North-West Frontier Province. The total recorded mortality from contagious disease was 3,048. The reduction in mortality which occurred is attributed mainly to reduced virulence of rinderpest during the year. The main causes of death were hæmorrhagic septicæmia and rinderpest among bovines, and anthrax among other animals.

(4) Veterinary Research and Investigation.

At the conclusion of the year under review, the Muktesar Research Institute lost the services of its Director, Dr. J. T. Edwards, B.Sc., D.Sc. (London), M.R.C.V.S., who relinquished the appointment on the 31st March, 1929. Ever since he took up the duties

in 1921, Dr. Edwards had applied himself enthusiastically to veterinary research, and a great deal of fundamental research work, of much practical and economic value to India, was accomplished during his eight years' tenure of the appointment. The following may be particularly mentioned for their value to India :—

(*a*) A mass of valuable fundamental laboratory research, carried on uninterruptedly for years, on rinderpest serum, as regards its preparation and the estimation of potency; the best and most economical serum-producers available; the characters of the immunity produced; the best virus-producers; the best methods of preservation and storage; the duration of potency and of the immunity conferred; the effect of heat and other factors on the keeping properties of this and other sera; the best preservatives for use in India; and the causes of hæmolysis in serum prepared from buffaloes.

These studies have produced a great deal of precise information on many points which had not previously been accurately determined for conditions obtaining in this country.

(*b*) Reorganization of the system of production and testing in the light of the above observations, so as to make greater use of a plains serum institute, at Izatnagar, to increase the output of rinderpest serum and other products.

(*c*) The employment of goat virus as a safe and convenient product for use in the serum-simultaneous method, particularly for the protection of imported cattle, highly susceptible to the piroplasmoses which are liable to be transmitted in virulent blood from indigenous animals.

(*d*) Observations on the treatment of Indian trypanosome diseases, with various drugs, which have resulted in highly successful and economical methods of treatment for surra in the principal domesticated animals of India. These methods are now being successfully applied in areas where surra is of serious economic importance. A method for the complete sterilization of the spinal fluid of equines by the intrathecal injection of Bayer 205 which was also devised by Dr. Edwards at Muktesar.

(*e*) The production from a large number of local strains, of a germ-free vaccine (aggressin) for protection against blackquarter, which is being used with very satisfactory results.

In addition, Dr. Edwards wrote a number of valuable brochures and scientific articles on a variety of professional subjects.

In accordance with the recommendations of the Inchcape Committee, the cost of all this research had, during recent years, to be paid for by the sale of biological products. This is never a sound policy anywhere, and in India, owing to the enhanced price which had to be charged for the laboratory products in consequence, has definitely had the effect of checking the use of these products, to the detriment of the stock-raising industry.

Imperial Institute of Veterinary Research.

Since the commencement of the 1922-23 financial year, production at Muktesar has been carried out as far as possible on a self-supporting basis, the total cost of this Institute and the Izatnagar sub-station being covered by the sale of the biological products produced.

To ensure this the Director has been compelled to devote a great deal of his time to administrative detail and, owing to the lack of sufficient staff, the Muktesar Institute has never been in a position to organize the systematic team work, by specialists, which the complexity of modern research demands. Sanction was however obtained for extra staff, with this object in view, and when production work has been placed on a separate basis, at the Izatnagar Serum Institute, it is hoped that it may be possible to obtain the extra personnel required for the better organization of research at Muktesar.

In this connection a motor road to Muktesar is badly needed, and would improve the amenities of this very isolated institution, apart from the greatly increased efficiency and reduced cost of maintenance which would result therefrom.

The post of First Veterinary Research Officer remained vacant throughout the year, and though the post of Second Veterinary Research Officer was filled by a temporary appointment, it was

necessary to employ this officer on serum production work at the Izatnagar sub-station. Moreover, the Helminthologist, appointed in August 1928, relinquished the post, in March 1929, on obtaining employment elsewhere, while the other new post created, for a Bio-Chemist, remained vacant throughout the year.

It is obvious that no one man can, in these days, deal with all the widely different aspects from which disease problems have to be considered, and until more research workers are available, it will be impossible for the Muktesar Institute to carry through the mass of fundamental research which the multifarious disease problems of India demand. Further, until the business side of the production of such large quantities of sera and other biological products has been separated from research work, as is now being arranged, far too much of the energies of the directing staff must be taken up with the administrative detail of preparation, testing, storage, despatch, and costing of these materials apart from the administration of the Research Institute itself.

During the year under review, laboratory research regarding improved methods of rinderpest control was continued, and the use of the goat virus method of serum-simultaneous inoculation was further tested in the field.

The treatment of surra in equines by intravenous and intrathecal injections of Bayer 205 was further explored, and large numbers of horses and camels and some hounds, have now been successfully treated with this drug.

Important observations were made regarding the attacks of acute Theileriasis from which the majority of pure-bred imported bulls suffer shortly after arrival in India. A number of such bulls, imported from South Africa, had been premunized against the South African *Theileria Mutans*, in the hope that some protection against the similar small Indian piroplasm might be obtained, but this did not prove to be the case and a high proportion died in spite of every kind of treatment adopted. Efforts are being continued however to discover a specific drug for the control of this parasite, which is of very great economic importance to India. It is constantly met with in the course of rinderpest inoculation and

is evidently capable of causing severe illness in susceptible cattle, while it no doubt seriously stunts the growth of indigenous young stock.

Laboratory observations were carried out during the year on the transmission of the virus of foot-and-mouth disease to guinea pigs and its maintenance in those animals, and experiments were continued to ascertain the vaccinating relationship between the bacillus of Johne's disease and that of avian tuberculosis.

Observations on the so-called ' Ranikhet ' disease of fowls having indicated that the serum of recovered birds may have protective powers, work was continued to endeavour to manufacture a protective serum which could be issued for the protection of susceptible birds, and this work is still proceeding.

Similar experiments were in progress for the production of anti-tetanic serum, and interesting observations and experiments in treatment were carried out on Kumri, cases of which were sent to Muktesar from affected areas. One of the methods of treatment tried for this peculiar disease was similar to that adopted for general paralysis of the insane in human beings, the animals being infected with surra, instead of malaria, and subsequently cured of the surra infection by means of Bayer 205. The results in the cases treated, which were of long standing, were not very encouraging, but work on this disease is also being continued.

During the year a completely avirulent strain of the glanders organism (*B. mallei*) was obtained by repeated inoculations on agar slopes which, in spite of its loss of virulence, appeared to be capable of producing mallein of only silghtly reduced potency, while the anti-serum appeared to have some slight effect in delaying the course of the disease in guinea pigs.

The results were not conclusive and the work is being continued, but the fact that this organism, though completely avirulent, was capable of producing a potent mallein, is of interest, and may help to explain certain obscure outbreaks of glanders in which large numbers of reactions have occurred among apparently healthy animals.

Experiments in vaccination against equine abortion, with killed cultures, were carried out on an extensive scale in military breeding studs, in collaboration with the military veterinary officers in charge, but were not complete and the work was being continued. Observations were also made at the laboratory on a number of cases of pneumonia in cattle and goats, the cause of which appeared to be an organism of the pasteurella group.

A vaccine prepared with this organism did not prove effective however, and further observations will be made, as opportunity offers, with a view to ascertaining if some other organism may not be the primary cause of this condition, which at present causes heavy mortality in many parts of India.

In addition to the above, work was started or continued on blackquarter, nasal granuloma, malaria in buffaloes, and fowl pox.

The quantities of the commonly employed protective substances issued from the Muktesar Institute, during the year under review and during the previous year, were as follows :—

	1928-29	1927-28
Rinderpest serum (5 c.c. doses) .	4,932,954	4,860,758
Hæmorrhagic septicæmia serum (15 c.c. doses)	480,648	467,072
Hæmorrhagic septicæmia vaccine (5 c.c. doses)	490,780	448,153
Anthrax serum (15 c.c. doses) . .	40,033	48,155
Blackquarter serum (15 c.c. doses) .	83,953	38,669
Blackquarter aggressin (5 c.c. doses)	222,419	133,401
TOTAL .	6,250,787	5,996,208

From these figures it may be seen that the popularity of the main products of the institution is still increasing, and it may be noted that 810,655 doses of rinderpest serum of the total of 4,932,954 issued were special serum for the serum-simultaneous method. This is an increase of 420,358 compared with the number of doses of this special serum issued during the previous year, and appears

to indicate that the mistrust of the serum-simultaneous method which formerly existed is now decreasing.

In addition, 34,309 doses of mallein, 1,323 doses of tuberculin, and 943 doses of avian tuberculin, were supplied for diagnostic purposes, while vaccines were prepared against strangles and contagious abortion (bovine and equine).

A number of autogenous vaccines and 450 doses of fowl cholera serum were also prepared.

Disease Investigation in the Provinces.

During the year, though the necessary accommodation and facilities were not complete, the Research Officer appointed to the Punjab Veterinary Service made a start with local investigations regarding the treatment of foot-and-mouth disease, Deg disease of buffaloes, and 'Ranikhet' disease of fowls, and a great deal of valuable work was carried out at the Punjab Veterinary College, particularly as regards the treatment of surra with intravenous and intrathecal injections of Bayer 205.

Special surra-treatment centres were started and a large number of animals, including equines, camels, and cattle, have now been subjected to this treatment with very satisfactory results.

Experiments in the treatment of parasitic diseases of equines were also continued at this College.

At Sohawa the fly survey operations, restarted in 1926, were abandoned owing to the inadequacy of the staff available to carry out this work, but experiments were continued regarding the effect of drug treatment on Trypanosomes in the blood and spinal fluid. A large number of camels were treated for surra with Bayer 205 and further observations were made on the tick O. *Crossi*, which is considered to be an important vector of Trypanosomiasis to camels in this country. It is to be regretted that the Punjab Government has decided to close the Sohawa Laboratory from March 31st, 1929, for financial reasons.

At the Madras Veterinary College, observations during the year showed that the small Indian piroplasm is very commonly met

with among young stock in the Presidency, and experiments were made to endeavour to find a specific form of drug treatment.

The systematic collection of entozoal and other parasites was continued, various drug treatments for entozoal parasites were under test, and observations were made regarding different types of trypanosomes met with in the Presidency.

Further observations were made during the year on the organisms of bovine lymphangitis of cattle and of nasal granuloma of cattle, while an outbreak of jaundice among the hounds of the Madras Hunt Club was traced to lepto-spiral infection, which had not been observed in India previously.

An officer was deputed to collect material at government farms for the study of contagious abortion, which continues to occur and is apparently not due to *Bacillus abortus* (Bang.).

Rinderpest virus production, commenced during the previous year, was continued, 119,175 c.c. of virus being issued, and it was found that a very satisfactory virus could be produced locally, and maintained indefinitely, by passage through plains cattle and buffaloes alternately.

Preliminary investigations were made regarding an epizootic which occurred among poultry and also affected crows in the Presidency.

In Burma, arrangements were under consideration for the erection of a fully equipped research institute for the local production of rinderpest serum and experimental work on the serum-simultaneous method was proceeded with. It was concluded that the double inoculation against rinderpest in adults is relatively safe in Burma, though the majority of the animals experimented with were chronic carriers of surra.

Extensive experiments were carried out to derermine the dose of rinderpest serum for Burmese cattle, and work on anthrax resulted in a satisfactory vaccine for elephants being prepared in the Provincial Laboratory and used by a number of commercial firms.

The collection and classification of parasites was commenced and a number of Bulletins were issued regarding the more important stock diseases.

All of this local research work is of great value in furnishing exact information regarding the local disease conditions which may be met with in the various areas concerned, and it is to be hoped that in course of time facilities and staff will be provided, in all major Provinces, for the extension of such work.

Special lines of research can be taken up by the staffs at the different veterinary colleges, but, for the systematic investigation of local disease condition some suitably trained personnel at the disposal of the Director of Veterinary Services is essential to efficiency.

CHAPTER VI.

(1) LIVE-STOCK BREEDING.

Cattle-Breeding.

Progress has been made during the year with schemes for the improvement of indigenous breeds of cattle throughout India, and it is generally reported that cultivators are taking greater interest in their cattle. An exception to this statement has to be made in the case of small grantee breeders in irrigated areas, where more profit can be made from crops than by cattle-breeding and it is difficult to arouse much interest in cattle-breeding. Improvement in the young stock is reported to be very noticeable in areas where Government stud bulls have been in use for some years and conditions are favourable. Results are stated to be particularly encouraging in Provinces where the policy pursued has been that of concentrating the work in certain selected areas where reasonably pure breeds of cattle already exist.

Good feeding and a healthy upbringing are however essential to live-stock improvement, and no marked permanent grading up can be expected unless provision is made for adequate reserves of forage for the dry months, and until steps are taken to overcome adverse factors, such as parasitic infestations and mineral deficiencies, which are known to occur in certain areas over large sections of India.

Suitability for draught is still and must continue to be the main consideration in selecting stud bulls for general use throughout India, but it is stated that increasing importance is being attached by cultivators to milk pedigree.

So long as milk production is not raised to such a high standard as to cause loss of vigour this may do no harm and, for some time to come, the milk yield of the indigenous Indian breeds is not likely to reach a level at which the physiological strain is very great. At Hissar farm, however, this year, a Hariana cow, as a result of special feeding, gave a yield of 8,134 lbs. of milk during a lactation period of 305 days, a yield which would be considered satisfactory for

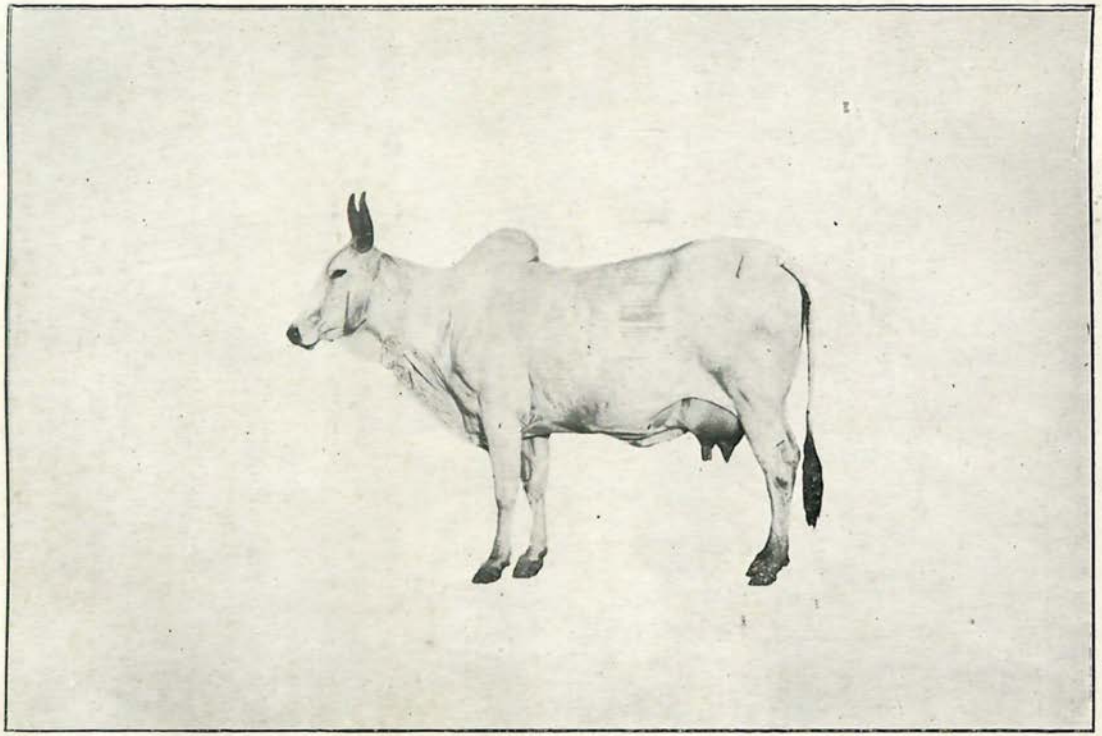
dairy purposes in any country, and caution is necessary to insure that milk production is not pushed too far. The accompanying photographs (Plates VI and VII) will serve to illustrate the different lines on which the more placid milking type, and the essentially working type of the same breed of some of the best Indian cattle tend to develop.

It is satisfactory to note that the use of sires of European blood is now almost entirely confined to areas where high milk yields are essential, for the supply of milk to cities for instance, while the demand for improved bulls of the best indigenous breeds is steadily increasing.

The number of such bulls issued up to the present is too small to have had much direct influence on the type of cattle now being produced throughout India, but they should be of great value for propaganda purposes, by encouraging better care of the young stock in particular. A word of warning appears to be necessary however as to the use of high class bulls in areas which, under existing circumstances, are definitely unfavourable for the development of such cattle, because experience has shown that it is unprofitable to attempt to raise high class stock, of any kind, in an unsuitable environment.

To give an extreme illustration, it would be worse than useless to attempt to raise high class cattle in the hills, under the conditions in which the small hill breeds are raised. Even if arrangements were made for heavy extra feeding, at prohibitive cost, the result would be disappointing, and it would be more profitable to spend the money on improving the local breed, by better feeding and selection. This will in all probability be found a sounder policy for many of the poorer parts of India than to introduce the blood of big high-grade cattle of a different breed, which it is not practicable to maintain economically except in rich country.

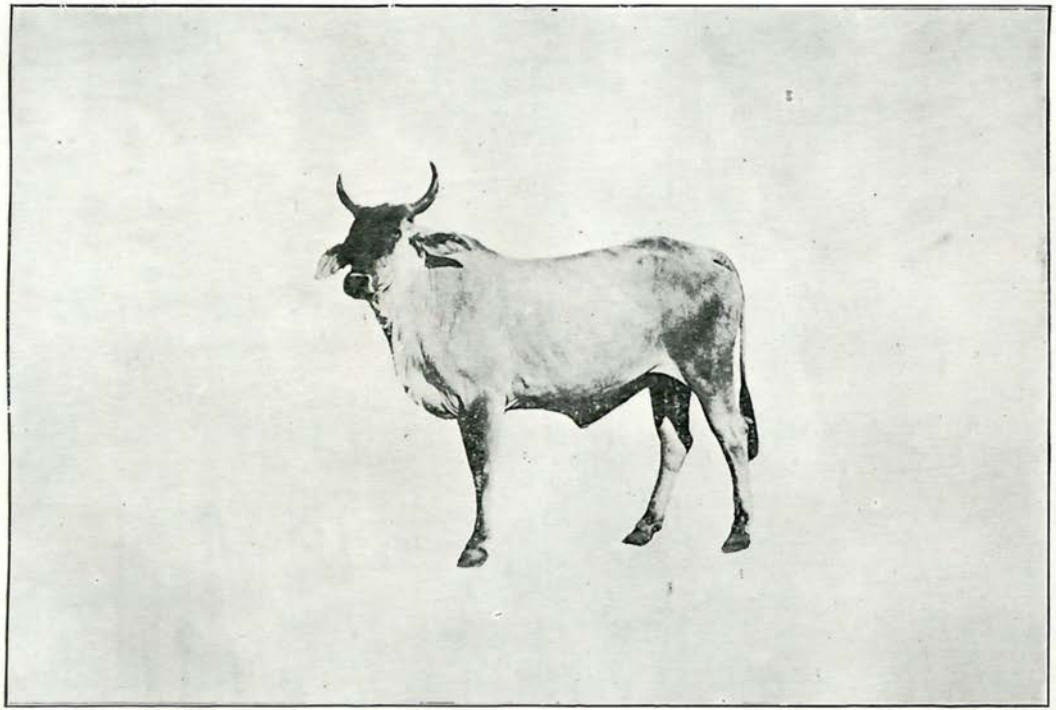
Moreover, local breeds, by long association with adverse factors, such as parasite diseases or mineral deficiencies, acquire a certain amount of hereditary tolerance of these factors; an asset, not possessed by imported cattle, which is well worth retaining.



Cow Hissar (Hariana) breed ; typical of the dual purpose type.
Reproduced from the Annual Report of the Department of Agriculture, United Provinces, 1928-29.

PLATE VI

LIBRARY OF THE BOMBAY BRANCH OF THE ROYAL ASIATIC SOCIETY



Cow Hissar breed ; typical of the draught type.
Reproduced from the Annuat Report of the Department of Agriculture, United Provinces, 1928-29.

PLATE VII.

What India particularly wants is a highly efficient animal, *i.e.*, an animal which will produce the maximum output of work and milk on the minimum of food, particularly during periods of shortage. It is obvious that under-sized and diseased animals are uneconomical but it does not appear to be always realized that it is also uneconomical to maintain very large cattle in areas where the cultivation can be equally well done by smaller animals, less costly to feed.

The most efficient animal is usually the animal of quality rather than bulk, a perfect specimen of its breed which has not been stunted by periods of semi-starvation or other adverse conditions; and the position of the ordinary cultivator in India is quite different from that of pedigree stock breeders who can afford to spend large sums of money on extra feed and care, because they can obtain fancy prices for any outstanding progeny. But even they often find the rearing of high class cattle too costly to be profitable. For practical dairy farming excessively high-yielding cattle are moreover not always the most profitable in the long run, in any country, and it will never pay the ryot of India to expend more in rearing and feeding than he can get back in actual work and milk. This immediate economic aspect should never be lost sight of in any scheme of live-stock improvement for this country, nor should it be forgotten that from indiscriminate crossing only mongrels can result which cannot be relied on to breed true to any type.

Few local breeds of Indian cattle can claim to be pure, but the characteristics of typical specimens of foundation breeds have been carefully recorded by the Veterinary Service in the past, and better results are likely to be obtained by in-breeding for a time to particularly good representatives of local breeds than by crossing them with superior animals of an entirely different blood and type.

In-breeding to outstanding animals to establish a type is the method by which most of the improved breeds have been produced, and the same principle is constantly applied to-day in all progressive stock-raising countries, but care is necessary to insure that vigour is not lost by persisting too long with this system of mating and that the stock inbred to in the first instance is thoroughly sound.

A constant supply of large numbers of improved bulls will be required to counteract the tendency to deterioration which is bound to occur in the conditions under which the ordinary stock of the ryot are bred and maintained, and the policy of grading up the best existing breeds in their own localities, so that large numbers of young improved sires will become available for other districts in which the same breed predominates, is undoubtedly sound.

Government farms can do much good by demonstrating the advantages of careful selection and better feeding, but they cannot be expected to produce more than a limited number of improved sires for issue. The bulk of the sires employed, therefore, will ultimately have to be produced by private breeders in their own herds, and experience in the United Provinces has shown that in favoured areas such breeders fully appreciate the value of good sires and can be trusted to feed and care for young improved bulls satisfactorily, to insure their proper development. If breeders can be induced to have their inferior bull-calves regularly castrated every year, before they have been able to reproduce themselves, much good can be done by purchasing young improved bulls and issuing them to suitable owners at an earlier age than is the custom at present, and as an inducement to permit castration at the proper age, it is suggested that arrangements might be made to inoculate all improved young stock against contagious diseases at suitable age, provided that their owners would consent to the castration of the males at the same time.

The breeding of buffaloes for the production of milk, and particularly *ghi*, is carried on in most Provinces, and herds of Murra buffaloes are maintained to provide bulls for the improvement of local strains. Difficulty in the rearing of Murra buffalo-calves is being experienced in certain areas, however, owing probably to parasitic infestation and other local causes such as mineral deficiencies. Some local strains of buffalo, of much poorer physique, but better able to withstand such adverse conditions, than Murra buffaloes, are, however, good milkers, while the improvement in milk yields which can be effected by the introduction of foreign strains of blood is generally not so marked in buffaloes as in indi-

PLATE VIII.



Hissar calf under 12 months (owned by Thakur Balwant Singh, Etawah) by village cow and Government Hissar bull.
Reproduced from the Annual Report of the Department of Agriculture, United Provinces, 1927-28.

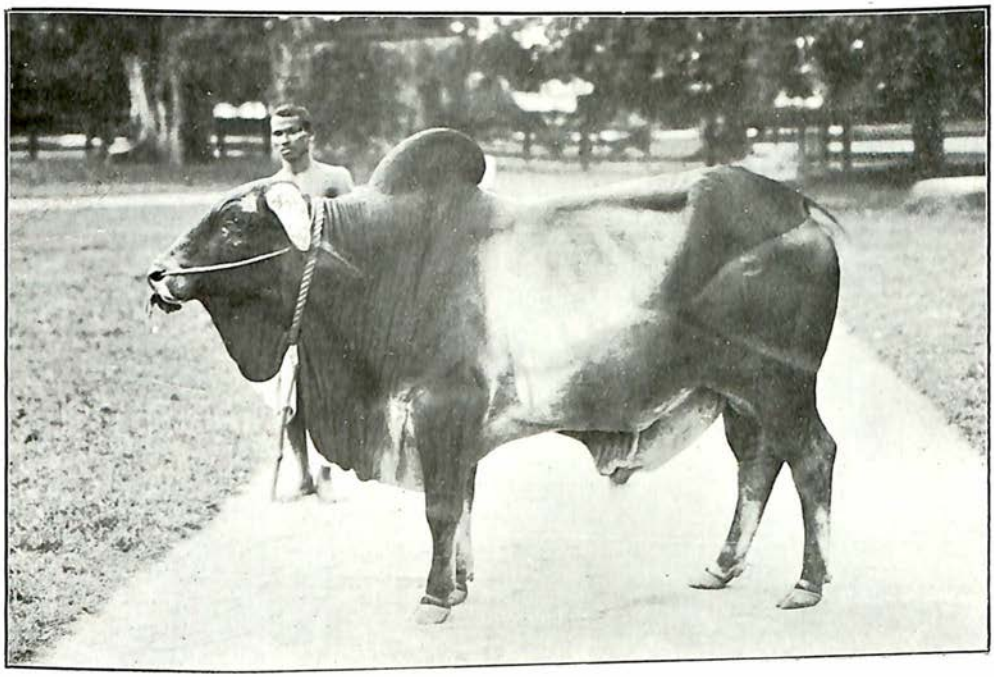


Fig. 1. Montgomery Bull.

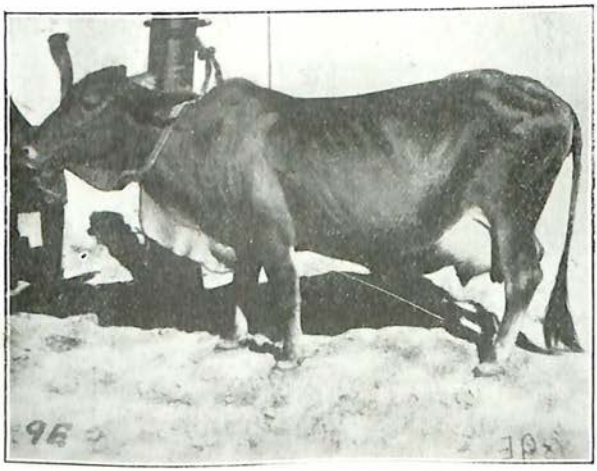
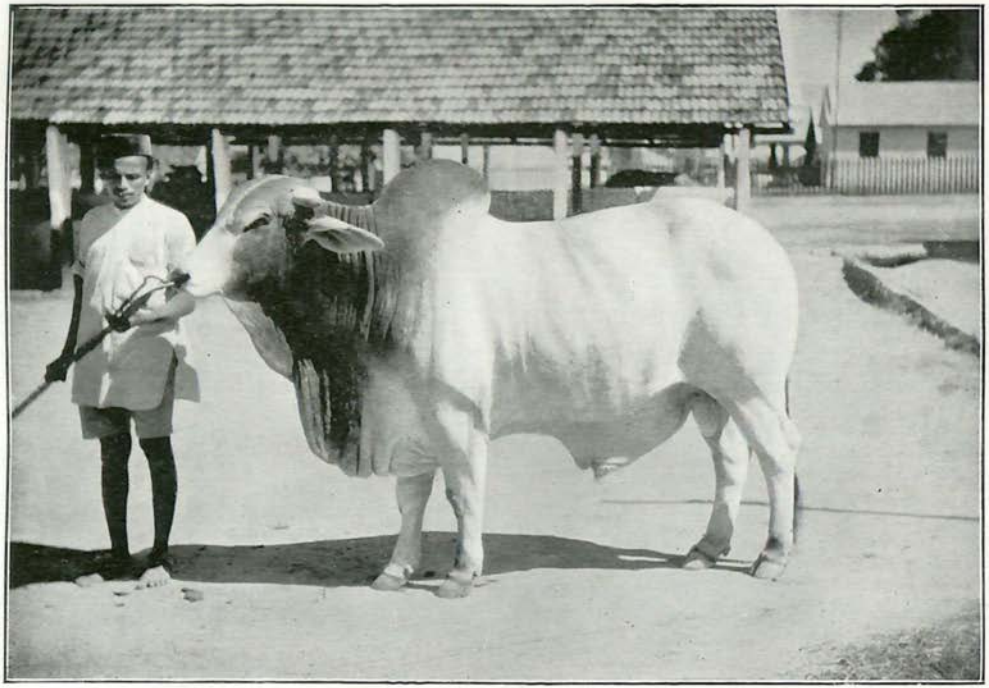


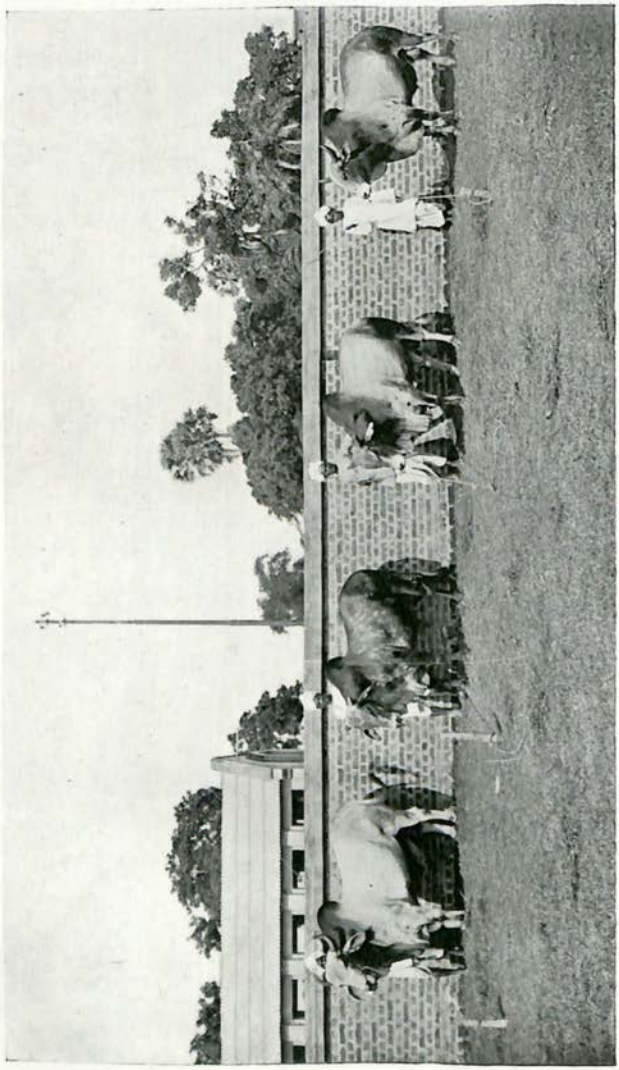
Fig. 2. Montgomery Cow.

Reproduced from the Annual Report of the Civil Veterinary Department, Punjab, 1928-29.



Montgomery Bull "Fiddle" of the Imperial Institute of Animal Husbandry and Dairying, Bangalore. Bred at the Agricultural College, Lyallpur. Age at the time photo was taken 5 years; weight, 1,322 lbs.; dam's best yield 5,606 lbs. milk in 340 days.

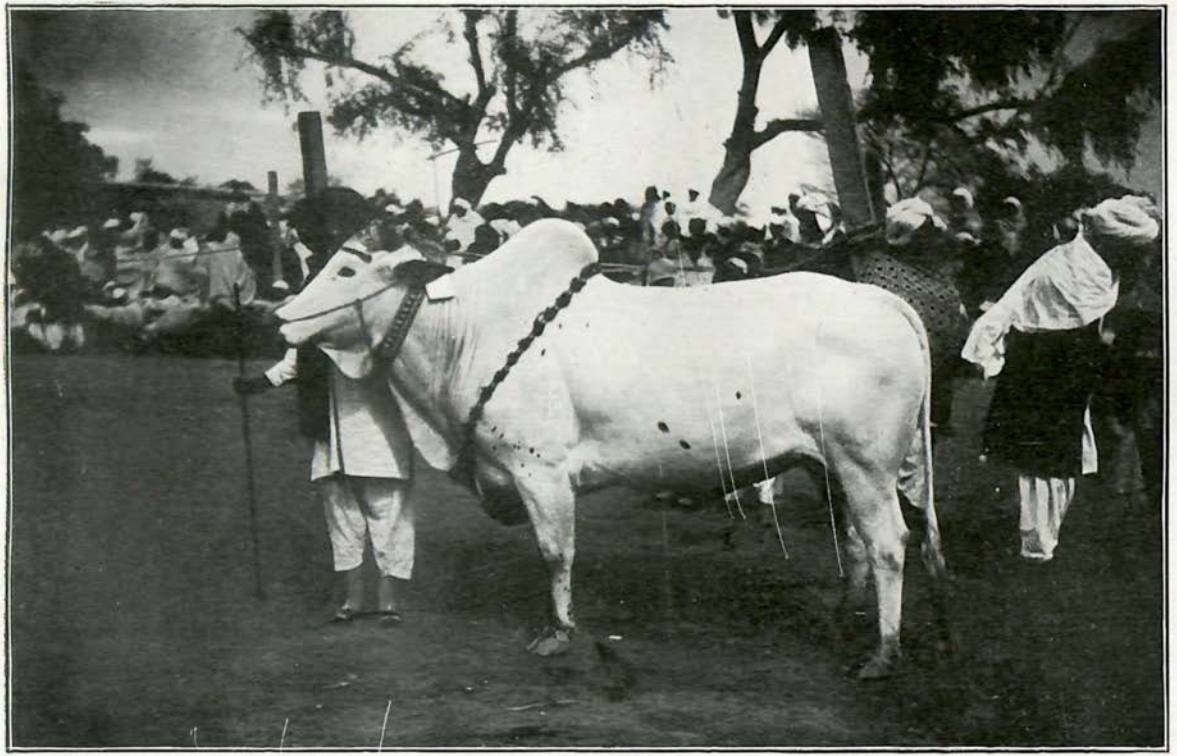
PLATE XI.



Thar Parkar Stud Bulls.

Reproduced from the Annual Report of the Civil Veterinary Department, Bihar and Orissa, 1928-29.

PLATE XII.



Subsidy bull Nuqra : Dhanni Breed (2½ years).

Reproduced from the Annual Report of the Civil Veterinary Department, Punjab, 1928-29.

genous cattle. This is no doubt because buffaloes have been kept primarily for milk production in the past, while the Indian breeds of cattle were bred for work almost exclusively, and it is questionable if Murra buffaloes are likely to prove a success in areas where the conditions are widely different from those to which this breed is accustomed.

In spite of the great increase in milk yield in certain dairy cattle in this country, brought about by the introduction of European blood, records show that buffaloes are still able to produce butter fat at a considerably lower cost than cows, and the use of buffaloes in irrigated areas for work as well as milk is reported to be extending, because buffaloes thrive better on stall-feeding.

The system adopted for the issue of bulls for breeding purposes differs in almost every Province ; in localities where cattle-breeding is not an important industry, bulls are supplied in small numbers only and are usually issued free of cost ; in other districts the premium bull system is being extended ; while in areas where cattle-breeding has been long established, and the value of a good sire is well appreciated, bulls are issued on payment, at reduced prices or on loan, often with the assistance of a Government advance.

The accompanying photograph (Plate VIII) shows the extent of the improvement which may be effected in the first generation, by an improved bull from a village cow, but the ryot requires to be educated to appreciate that this improvement is not likely to be maintained unless sires of the same breed are continuously employed and unless the young stock are well fed throughout the period of their growth and development to maturity.

In most Provinces, Government farms are now in operation for breeding bulls of the essentially working type, but a number of milking herds, usually of the Sahiwal (Montgomery), Thar-Parkar, or Sindhi breeds, are also maintained.

Typical specimens of Montgomery and Thar-Parkar cattle and the difference between these milking breeds and the essentially working type of Hariana and Dhanni cattle may be seen in the accompanying photographs (Plates VI, VII, IX, X, XI and XII).

An interesting development during the year has been the decision of Mysore State to domesticate its enormous herds of the famous Amrut-Mahal cattle.

In the Central Provinces, besides maintaining pure herds of Hariana, Malvi, Gaolao, and Sahiwal cattle, for the production of stud bulls, blocks of forest have been reserved for the grading up of local breeds, by repeated mating with Hariana or Malvi bulls until elimination of the local blood has been effected.

That improvement can be effected on these lines there is no reason to doubt, but no marked permanent grading up can be expected unless the conditions are such as to enable the improved young stock to develop satsifactorily, and it may be found necessary to improve or supplement the grazing if higher class cattle are to be maintained in these areas.

Considerable attention has been paid during the year, in most Provinces, to the production of a reserve of succulent fodder by means of silage pits, in which large quantities of foodstuffs are now being preserved, much of which would otherwise have been wasted.

Improved methods for the saving and preservation of the available food material were also studied and experiments were carried out to ascertain which are the most suitable forage crops, and the exact stage of growth at which they should be cut to obtain the greatest food value. This work is of particular importance to the live-stock industry of this country, because enormous quantities of valuable forage could be saved during the monsoon, the feeding value of which is now to a large extent wasted through not being saved at the proper time.

Apart from the purity of blood necessary to insure that the progeny will be true to type, the great secret in producing animals of the highest class is never to allow growth to be checked at any stage of development, and this can only be insured if an ample supply of suitable forage is available all the year round.

The severe check caused by the semi-starvation to which the vast majority of young stock are subjected in this country, can never be overcome, however liberal the feeding may be afterwards,

and no opportunity of impressing this fact on breeders and owners of stock should be missed.

Goats and Sheep Breeding.

During the year under review, the number of Merino rams issued from the Punjab Government Cattle Farm was increased from 8 to 73, but the breeders complain that Merinos are not so hardy as the local breeds and difficulty is experienced in inducing them to give the greater attention required to maintain these sheep in health.

Efforts are being made to improve the local sheep in the Kangra and Kulu valleys, by selection of the best ewes and rams and by forming a cross-bred flock with Merino rams.

In the Attock and Shahpur areas, marked improvement has taken place in the indigenous sheep during recent years, but Merino rams have not been successful, owing to the heat and insufficiency of grazing during the dry season.

Damani rams from the North-West Frontier Province were also tried but have not proved a success.

At the Government Breeding Farm, Karnal, a flock of Bikaner sheep is being graded up by selection for improved wool yield, and at Hosur, in Madras, the average clip of a flock of indigenous sheep has been considerably increased by this method.

At Tarnab, in the North-West Frontier Province, the flock of cross-bred Pusht-i-Koh and Hashtnagri sheep continued to do well, but difficulty has been experienced in obtaining Pusht-i-Koh rams as sires for the flock.

At the Hissar Farm, the nucleus of a flock of milking goats was formed, by purchases of selected animals, with the object of grading up the best indigenous goats available for milk production, in which respect some of the indigenous breeds show great promise.

Poultry Breeding.

In view of the large consumption of poultry and eggs in India, the breeding of poultry on improved lines is a subsidiary industry of considerable importance, and efforts are being made in certain Provinces to take up poultry-breeding on modern lines.

In the United Provinces considerable progress was made, with the aid of a Government grant, but poultry diseases have interfered greatly with the progress of poultry improvement schemes in other Provinces.

Some investigation of Indian poultry diseases is being carried out at Muktesar and elsewhere, and it is to be hoped that something may emerge to overcome this difficulty, but the matter is one regarding which continuous research by a specialist is urgently necessary in India on the lines now being adopted in all progressive agricultural countries.

(2) DAIRYING.

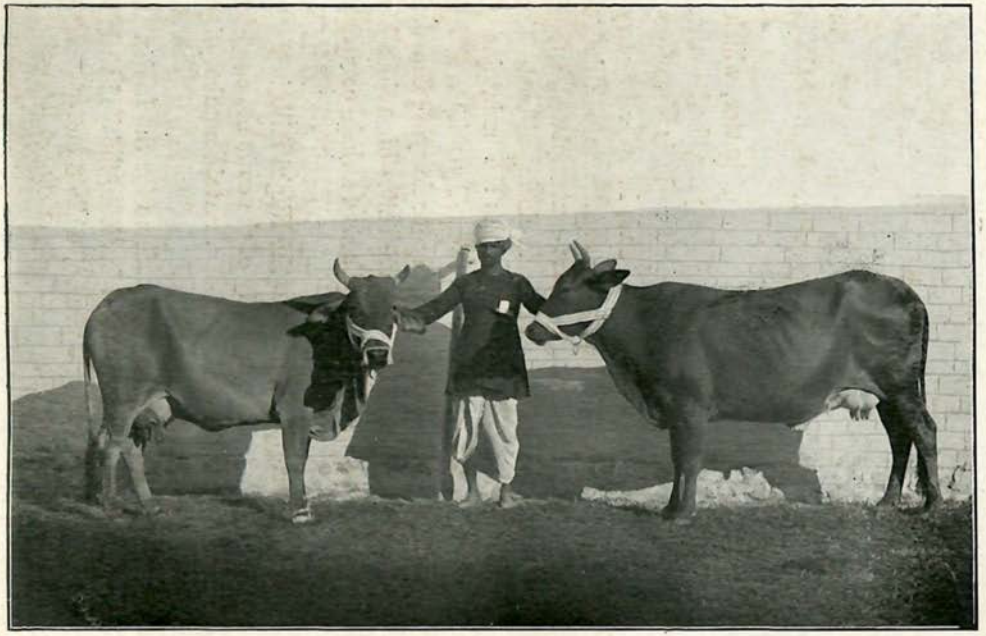
The Imperial Dairy Expert reports an ever-increasing interest by the public in cattle-breeding and dairying, and this was greatly stimulated by the publication of the Report of the Royal Commission on Agriculture in India. In consequence of the publication of this Report, the demands on the Central Bureau of Animal Husbandry, for information and guidance, have greatly increased, and much advice has been furnished to a great variety of enquirers, comprising Provincial Governments, Indian States, Municipalities and private individuals.

Further advance has been made during the year in the organisation of city milk societies and co-operative milk unions, and the Dairy Expert rightly points out that this work is of great importance, as in all small-holding countries of the world, the improvement of dairy cattle has followed and not preceded the formation of such co-operative organisations.

Investigation and research, regarding the treatment of village milk for long distance transport, and the manufacture of dried milk, condensed milk, casein, and milk products generally, was carried out during the year and is an important matter for India, as a means of ensuring that the small dairyman obtains the best possible outlet for his produce.

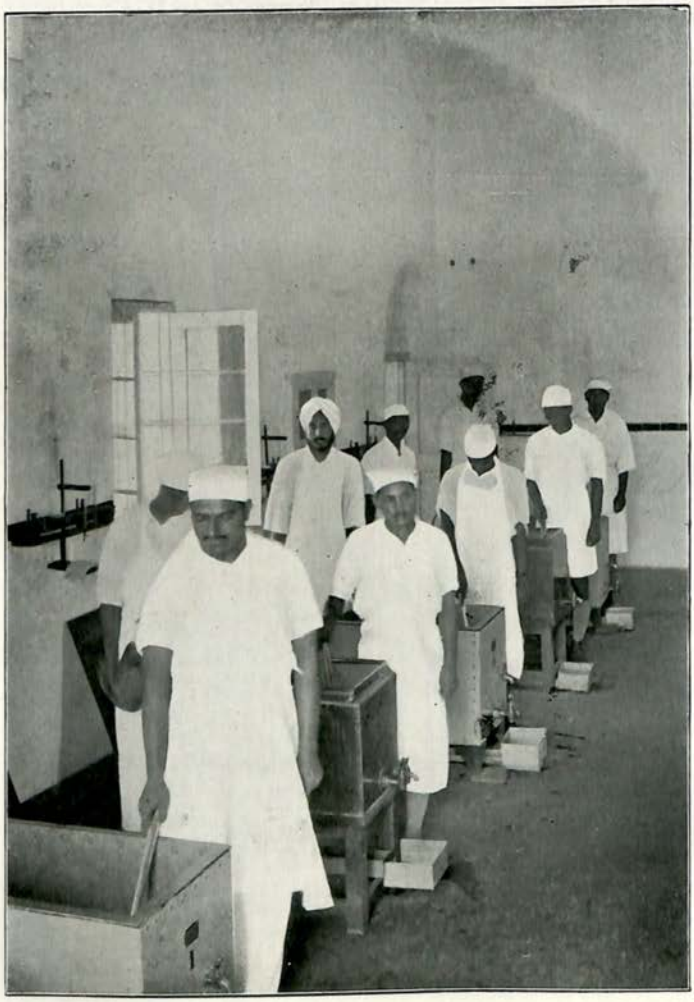
Considerable progress is reported at the Bangalore, Karnal, and Wellington farms, and at the Anand Creamery.

PLATE XIII.



¾ Mont. + ¼ Ayr. cows representing two distinct types, Imperial Institute of Agricultural Research, Pusa.

PLATE XIV.



Students making Cheddar cheese at the Imperial Institute of Animal Husbandry and Dairying, Bangalore.

The Karnal herd has now reached 623 of all ages and is being increased to a maximum of 1,000. The object aimed at this Farm is to produce stud bulls of a type which, though retaining high efficiency for work, is able to produce cows capable of furnishing a profitable milk yield in addition to rearing their calves.

Two types of Indian cattle are maintained, *viz.*, the Hariana, suitable for districts where powerful working cattle are required, and the Thar-Parkar, a smaller type suitable for smaller cultivators and light soils, while the establishment of a pure-bred herd of the Bhagnari breed, of Baluchistan, is contemplated.

At the Anand Creamery a large quantity of butter, which had been accumulated in cold store during the year, had eventually to be sold at a considerably reduced price. It is therefore not proposed to accumulate butter in future and, in order to carry out research work in connection with the manufacture of dried milk, the establishment of a milk drying plant is contemplated, as well as a tin making plant for the manufacture and closing of butter tins.

At Bangalore a few pure-bred Sindhi cows are maintained, but the majority of cows are cross-breds between Ayrshire and Indian cattle. This farm is maintained essentially for dairying instruction, and it is considered an advantage to have cattle of various breeds and crosses, for the instruction of pupils as to their comparative merits.

At Wellington the supply of milk to the Nilgiri Hills is the main consideration, and here too the majority of the cows are cross-breds, between European and Indian cattle, but a certain number of pure-bred Ayrshire and Sindhi cows are kept.

At Bangalore, the fourth group of students for the Indian Dairy Diploma at the Allahabad Agricultural Institute finished their term in December 1928, and 3 out of 6 passed, while 3 out of 4 students who failed to pass in the previous year passed this year.

During the year, technical instruction was given at the Bangalore and Karnal farms and at the Government Creamery, Anand, to 4 students from Assam, Bihar and Orissa, and Kapurthala State, and to 12 Dairy Diploma students of the Allahabad Agricultural Institute (Plate XIV). In addition, one cattle farm superintendent and

4 European soldiers were trained in dairying and cattle-breeding at the Bangalore Dairying Institute. Five post-graduate students and 1 post-diploma student completed their courses of training during the year, and 3 post-graduate students joined in January 1929, while the research scholar from the Punjab continued his research.

Much assistance was given by Mr. F. J. Warth, Physiological Chemist, and his staff, in the training of students and the examination of feeding stuffs.

(3) ANIMAL NUTRITION.

During the year, at the request of the Government of India, plans for an enlarged Animal Nutrition Institute were prepared and submitted, and the provision of such an Institute is still under consideration.

Such an institution, for the exact analysis and scientific study of the great variety of food-stuffs produced in different parts of India, is badly needed, in order that the greatest possible food value may be obtained from the limited supply of fodder available. The work of such an institution will be of ever increasing value to stock-owners as exact analyses of all kinds of Indian fodders are made and published, and when stock-men have been educated to make constant use of this information for the economical feeding of their animals.

In view of the admitted shortage of cattle food, the necessity for its economical employment needs no emphasis, but it does not appear to be fully recognized that enormous waste at present occurs through the inability of the stock raised in many parts of India to make economical use of their food, owing to digestive derangement, disease, and stunted development caused by mineral and other deficiencies in their food.

Adverse factors of this kind are known to exist over very large tracts of country in India, and some work is being done to overcome the mineral deficiencies met with, but systematic scientific investigation of this problem is becoming of greater importance every

year, owing to the increase of cultivation, and the extension of irrigation.

Recent observations, made in this country, on the feeding of minerals to animals maintained on locally grown fodder, have given striking evidence of the improvement in general health and development which result from correct adjustment of such deficiencies, and it is very evident that investigation of mineral deficiencies is of the greatest economic importance to India.

Much can be done by practical feeding experiments in particular areas, but reliable results which can be generally applied can only be obtained by exact analysis of the foodstuffs grown, and by careful physiological and pathological investigation of the effects of any deficiencies discovered, on health and development.

The practical importance of expert investigation of such problems was amply demonstrated at the commencement of the present century by veterinary research workers in South Africa, whose work has since been followed by other workers in every progressive stock country of the world, and instances of the profound effect of such defective feeding are not wanting in India. Up to the present, adequately trained staff and facilities for dealing exhaustively with such problems have never been available in this country but valuable work on the composition of Indian fodders has already been carried out by the Physiological Chemist at the Nutrition Section of the Imperial Institute of Animal Husbandry and Dairying, Bangalore, and it is hoped that the results of this work will shortly be published in a form which will be available to stock-feeders throughout India.

One of the most important of the many problems, which this Institute will have to study when staff and facilities are available, is that of ascertaining the best practical methods of conserving the enormous quantities of naturally-grown fodder produced during the monsoon.

At present, owing to faulty grazing and failure to preserve the enormous mass of food material produced, at the proper time and by the most suitable methods, a very large proportion of its feeding value is lost. In consequence of the gradual contraction of grazing

areas, the proper utilization of every kind of food material produced is a matter of the greatest importance and no effort should be spared in endeavouring to evolve methods of preservation suitable to local conditions. The problem is beset with difficulties. Any advance towards a practical solution will have to be controlled by exact chemical analysis of the forage produced and physiological investigation of its digestion. During recent years, striking results have been obtained by scientific control of grazing, and thorough investigation of this subject by a nutrition institute in India is also very necessary.

Nutrition Experiments on Growing Animals. During the year under review experiments on the nutritive value of gram husk as a food for calves were carried out and, though not yet complete, show that this food has a distinct feeding value.

A similar test was made of *ragi* (*Eleusine coracana*) straw silage as a food for young stock at Bangalore, and a series of tests was undertaken to compare the values of typical Indian oil-cakes for milk production.

Further experiments were carried out with a number of other Indian fodders, and it is hoped that it may be possible to publish a table of digestibilities of the commonest of these at an early date.

Other experiments made were to determine the nutritive value, at different stages of maturity, of the principal fodders available in India. Green fodders, cut at different stages and fed as such, and identical material converted into hay and silage were tested as to their food values, and the information obtained is being prepared for publication.

Similar tests were made, in collaboration with the Military Grass Farms Department, on cuttings of grass at different stages, and the variation in crude protein in the different cuttings was found to be as follows :—

	Per cent.
1st cut	5·56
2nd „	3·81
3rd „	1·98

Digestion experiments with the same material gave the following digestion co-efficient results, *viz* :—

	Crude protein per cent.	Crude fibre per cent.
1st cut	44·8	76·0
2nd „	31·7	66·7
3rd „	..	57·8

Further experiments are being carried out on these lines and the results will be published.

This work is of great importance for agriculturists and stock-owners in India because a large proportion of the protein produced is wasted, under present circumstances, owing to the crops being allowed to become too ripe before they are consumed or cut.

During previous years, tests of the mineral requirements of cattle produced no evidence of mineral deficiency, under the conditions of the test, but further tests on different lines are projected. Similar work is being carried out to determine the mineral constituents of pastures, from different typical soils and under different climatic conditions. Considerable progress with this enquiry has been made during the year, and marked differences have been found to exist between the mineral content of various pasture grasses from the different farms tested. As a general rule, advancing maturity was found to be associated with a decline in phosphorus, while lime did not decrease to the same extent.

A modification of procedure for the determination of protein digestion was made use of during the year, at Bangalore, to test the digestibility of concentrates, and arrangements have been made to test a number of typical Indian concentrates by this method.

Observations were also made on the preparation of green fodder silage, under different conditions of moisture and at different stages of maturity. *Juar* (*Andropogon Sorghum*) silage has been tested very fully in this way and the results are being prepared for publication. The losses of dry matter observed in this series of experiments, on *juar* ensilage, varied from 1·75 to 10·58 per cent., the average loss being 5·9 per cent., while the loss of protein varied from 1·8 to 17·8 per cent., the average in this case being 11·8 per cent.

A chemical investigation was commenced to determine the digestibility of carbohydrates and a number of experiments were made as to the suitability of wheat and other straws for silage. Wheat straw silage was found to be readily eaten by cattle which would not eat the raw wheat straw, and the silage proved satisfactory in every respect, digestion results being satisfactory. The trial of wheat straw silage in tracts where wheat is largely grown is therefore recommended, for providing moderately succulent feed in the hot weather. Two hundred and fifty parts of water were used for 100 parts of straw and the material was well pressed.

Physiological studies. Urination was studied with 30 different rations during the year, and remarkable variations were again noted. The experiments are not yet complete but at the present stage it appears that the degree of succulence of a fodder has no influence on urination. Marked differences in urination were again found to be associated with particular fodders, and it appeared that the stage of maturity of the fodder is likely to influence urination.

It is claimed that the past two years' work of the Nutrition Section, Bangalore, has given a new significance to the study of hippuric acid excretion. Work during the year has shown that the acid-base balance of the animal system is directly influenced by the excretion of hippuric acid, the reaction of the urine being dependent in great measure upon this substance. The quantities eliminated were found to be serious in several cases, and appear to indicate an unsuspected amount of potential benzoic acid in certain fodders. Though no trace of this acid was found in ordinary foodstuffs, every fodder tested contained precursors of benzoic acid and the potential benzoic acid content of various foodstuffs tested at Bangalore was as follows :—

	per cent.
Ripe *juar*	1·20
Ragi straw	0·97
Meerut hay	1·01
Groundnut cake	2·07

The quantity is however liable to vary considerably according to conditions of growth and the stage of maturity. It is stated that

the quantities of benzoic acid produced by some Indian foodstuffs would be very harmful if adequate supplies of glycine were not available, and though the quantity present in the fodders tested up-to-date seems to have been sufficient, the matter is one which requires further investigation.

Observations during the past two years have shown that certain fodders produce highly alkaline urines, while others produce acid urines. Ranges of pH from 5·6 to 8·5 have been observed and every fodder is characterised by urine of fairly definite pH.

A number of feeding experiments were also carried out at this institution in collaboration with the Madras Department of Agriculture, the Military Dairy Farms Department, and the Bombay Department of Agriculture, to determine suitable rations for working and milking cattle, and these will be continued.

During the year, four students were given a post-graduate course of training, and three were undergoing training at the end of the year. Two special research students, one from the Punjab and the other from the United Provinces, were also under training, and lectures were given to Dairy Diploma students on chemistry and animal nutrition.

CHAPTER VII.

VETERINARY EDUCATION.

During the year under review the training of veterinary students in India was confined, as hitherto, to four Colleges, *viz.*, Lahore, Bombay, Madras, and Calcutta, and the Insein school in Burma. It was anticipated that the buildings for the new Veterinary College at Patna would be completed by July 1st, 1929, but owing to difficulties in completing the water and light installations, and in securing the necessary College staff, it was not thought that this College would be able to receive students until July 1st, 1930. Having a breeding and dairy farm attached, this institution should prove a valuable centre for veterinary education, the course of instruction proposed being a 3-year course, similar to those at the Bombay, Madras, and Calcutta Colleges.

The Lahore College still provides a 4-year course, and the course at the Madras College, though of 3 years' duration, is being modified so as to deal with a more comprehensive curriculum than at present. These two Colleges also provide post-diploma courses for subordinate officers.

The educational standards required for admission, and the courses of training at the different Colleges vary considerably, and the necessity for uniformity has been recognised for many years, but no agreement on the subject has ever been found possible, largely on account of financial considerations. The matter is, however, now being taken up afresh and, in view of the recommendations of the Royal Commission on Agriculture in India, it is hoped that the whole subject of veterinary education, which is of the utmost importance to the live-stock industry, will now receive the special consideration of all Governments concerned, with a view to arriving at a uniform policy in the near future.

Bombay Veterinary College. There were 98 students on the rolls at the beginning of the year, and of these 67 passed their examinations successfully. Nineteen students, having passed the

final examination, left the College, and 46 new students were admitted during the year, including 2 old students readmitted.

There were thus 118 students on the rolls at the commencement of the first session. Of these, 10 discontinued the course, and 4 left College on passing the supplementary final examination, leaving 104 students on the rolls at the end of the year.

Four new scholarships were awarded, during the year, to students from the Bombay Presidency, thus making a total of 14 from the Presidency proper and 5 from Sind. The Central Provinces continued stipends to 11 scholars already at the College and sent 6 more. Baroda State continued stipends to two students and sent 1 more. Gwalior state continued stipends to two scholars already in the College, and Kolhapur and Barwani States sent one student each. The States of Jamkhandi and Miraj, and the Deccan Maratha Education Association, continued stipends to their students already at the College. There were in all 46 students in receipt of some assistance and 58 without such assistance at the end of the year.

Out of 57 graduates passed out during the last three years, 41 are in the service of Government or local bodies, 13 in the service of Indian States, 2 are unwilling to accept employment, and 1 has died.

Diagnostic bacteriological work was carried out at the College for the control of disease and for educational purposes.

Bengal Veterinary College. There were great demands for admission into the College from in and outside India, including Feudatory States, 340 applications being received during the year.

At the beginning of the session 184 students were on the rolls, of which 168 continued their studies throughout the session. Eighty-seven new students were admitted from various countries and Provinces and the number of new entrants from Bengal is on the increase. Among these students there were 2 graduates of the University, 2 Intermediate Science scholars and 132 Matriculates, and it is encouraging to note that a certain number of the best educated students are taking up veterinary work. Of the above total of 168 students, 101 held stipends.

During the year new pathological specimens, models, and charts were added to the Museum and were frequently used by the department, for educational purposes and for the Demonstration Train.

The systematic collection of entomological specimens has been continued and further anatomical specimens and skeletons were prepared by the Assistant Lecturer.

Diagnostic work was continued at the Raymond Research Laboratory and a number of auto-vaccines were prepared.

Punjab Veterinary College. During the year, the educational standard for admission into this College was raised to the Intermediate standard in the Science or Arts Faculty. One hundred and thirty-five candidates offered themselves for admission and of these 47 were admitted.

At the end of the year, the number of students at the College was 168. Nine students failed to complete their course of study and left during the year. The number of students passed shows a marked increase compared with previous years, and the demand for qualified men continues to exceed the supply. Measures are being taken to admit a larger number of the Punjab Civil Students.

In addition, there was a Farriers Course for which 27 candidates joined, including 10 men from the Burma Military Police. Eighteen farriers were passed out during the year and the class for dressers was re-started.

Much diagnostic, bacteriological, and local investigation work was carried out at this College, for the control and treatment of disease and for educational purposes.

Madras Veterinary College. Forty students were selected for admission during the year. Of this number, 34 were stipendiary and 6 non-stipendiary. The total number of students at the College at the end of the year was 98.

For the post-graduate course, held during the year for a period of six months, 9 veterinary graduates attended and 6 obtained certificates at the end.

The number of scholarships was increased during the year to forty, for each class, making a total of 120, and the number who

passed their examinations out of 96 who presented themselves, was 67, while all 5 passed at the supplementary examination.

This College has a well established research section, in which much valuable disease investigation is carried out and is systematically made use of for instructional purposes as well as for the control of disease in the Presidency.

Insein Veterinary School. The number of pupils at this School was 13 and the instruction was still in the vernacular, but it is now proposed to raise the standard of entrance to the High School Final and to conduct the teaching in English. Pending a decision on a proposal now being considered, to raise the stipend of students from Rs. 25 to Rs. 40, no recruitment of students is taking place and the School will be empty until a decision is arrived at.

Refresher courses for Veterinary Assistants were started during the year, 19 attending the first course and 21 the second. These courses were considered to have been of considerable benefit to those who attended, and might well be instituted in other Provinces.

For the future, a scheme is under consideration for the creation of a more fully equipped Veterinary College, with a staff capable of instructing up to a higher standard than at present.

The numbers of students under training, and who passed their final examinations during the year, at the different Colleges in India are shown in Appendix XI, page 226.

At the *Imperial Institute of Veterinary Research, Muktesar,* 4 officers of the Royal Army Veterinary Corps were given post-graduate courses of instruction, and 3 officers, one from the Central Provinces and two from Indian States, were also permitted to attend these classes.

One Veterinary Assistant Surgeon of the Bengal Veterinary Department attended for a 3 months' course of practical training, and one officer, of the Central Provinces Civil Veterinary Department, joined for an 8 months' course.

CHAPTER VIII.

DISTRICT WORK.

The figures given in preceding chapters illustrate the extent to which improved crops and other agricultural improvements have been introduced and have become part of the general agricultural practice of the country. This result has only been achieved by well-organised propaganda and extension work including arrangements for the supply of seed, implements and manures which in many other countries could be left to private agency from the outset. Indeed, the task of the Agricultural Departments in India is only half-finished when research and field experiments have proved the value of some new crop or method ; the improvement has still to be brought to the notice of thousands of small farmers—mainly illiterate and men of small resources—and the department must often act as seedsman or manure-seller at least until a supply organisation can be built up. In this chapter a brief account will be given of the principal methods employed in different Provinces and of any changes during the year. Progress in the introduction of new crops can be judged to some extent from the figures given in Chapter II showing that the ascertained area was over 12 million acres as compared to 10 million acres in 1927-28. Progress in the introduction of improved implements is much more difficult to guage, since the sales by and through the departments only represent a fraction of the total sales. Several firms are now actively engaged in implement manufacture, whilst many of the simpler implements are made, to an extent difficult to estimate, by small firms and individual artisans. To form any real estimate of the extent to which improved methods of cultivation have been taken up is still more difficult ; during the early stages of the demonstration of such improvements some idea can be gained of the rate at which it is being adopted, but this stage is soon passed. Moreover, as demonstrating staffs gain the confidence of the cultivator their advice is taken on a variety of matters, and the aid of the department is

sought in many directions. More important than the introduction of any single material improvement is the gradual and almost indefinable change in the outlook of the cultivator, and his recognition both of the existence of a department of Government which can assist him and of the fact that it is possible to raise the efficiency of his agriculture by the application of new methods. Such changes cannot be reduced to figures; that they are taking place is clear to many who in one capacity or another have been associated with the work of the Agricultural Departments and who have seen the scepticism of 25 years ago replaced by an active faith. For no Province, much less for India as a whole, is it now possible to measure the agricultural standard of one year against that of its predecessor. All that can be done is to review the organisation and methods employed and to comment on new developments and on the relative effectiveness of different methods of bringing agricultural improvements to the villages.

I. Demonstrations.

Though other methods of propaganda have not been neglected, *demonstrations on the cultivators' own land* under village conditions is the method of introducing agricultural improvements on which all Agricultural Departments place most reliance. The practical development of the method so that every village may be reached is not easy to arrange but the principal limitation has been financial. During the year all Provinces have expanded their demonstration staff. In Madras, 7,060 demonstrations were carried out, an increase of 1,630 on the previous year. In Bombay, the departmental staff carried out 1,167 practical demonstrations on cultivators' plots, and in the organisation of propaganda and demonstration increasing dependence is placed on the work of the *taluqa* development associations, of which 82 were actively at work during the year.

In Bengal, 2,613 practical demonstrations were carried out as compared to 1,934 in the previous year. In addition private farms run on modern lines are on the increase and are becoming of more assistance to the department in agricultural propaganda; eleven of these are specially mentioned.

In the United Provinces, field demonstrations were mainly carried out on privately-owned farms managed under the instructions of the departmental staff—a system which is considered well-adapted to the conditions of the Province and which has the advantage of enabling a number of demonstrations to be made at the same centre. During the year there were 964 such farms, of which 28 were aided by grants for special purposes, as compared to 871 farms in the previous year and 405 in 1924. The total area under village demonstrations, including those on land rented for the purpose, was 271,182 acres as compared to 195,430 acres in the previous year. The conclusion was reached that in the United Provinces the method now widely adopted of carrying out demonstrations on land hired from the cultivator is best suited to early demonstrations of new improvements ; once successfully introduced, an improvement can be spread to new places by demonstrations on cultivators' own lands supervised by the Agricultural Department's staff.

In the Punjab, 1,521 demonstration plots were laid out on cultivators' lands ; on some of these a number of different demonstrations were carried out.

In Burma, 800 practical demonstrations were carried out on cultivators' holdings under village conditions. In Bihar and Orissa the re-organisation and strengthening of the Subordinate Agricultural Service provided 20 additional agricultural assistants for demonstration work. During the year about 100 *kamdars* (trained demonstrators) were employed and carried out 3,603 demonstrations in cultivators' fields.

In the Central Provinces 45 demonstration plots were at work during the year, 29 more being arranged for the following year. As suggested by the Royal Commission, the comparative value of two types of demonstration plots is being determined ; in the first type the land is rented and all operations carried out by the departmental staff, in the other demonstrations are conducted on the lands of leading cultivators. These plots are, in addition to the ordinary demonstrations, organised by touring agricultural assistants.

In Assam, 1,703 practical demonstrations were carried out during the year including 708 demonstration plots of improved varieties of rice.

In Bihar and Orissa a "BETTER-FARMING" CAMPAIGN, involving the simultaneous demonstration of improved crops, implements and manures, was initiated in North Bihar by the provision of 10 special *kamdars* (trained demonstrators) each equipped with a cart, a pair of bullocks and a set of improved implements.

In the Punjab the same method of peripatetic demonstrators was found useful in the introduction of new implements.

In the Punjab better farming societies, organised co-operatively, increased in number and there are now twenty groups of such societies distributed in seven districts. In Madras, eight such societies were at work during the year in the Tanjore-Trichinopoly Delta and each maintained a demonstration farm. Concentrated demonstration has been attempted for some 4 years in the Punjab in 167 villages, the object being to demonstrate a number of agricultural improvements and, so far as possible, completely modernise the agriculture of the village. These demonstrations were continued, special preference being given to those villages in which the consolidation of holdings had been effected by the Co-operative Department and where, naturally, the scope for introduction of improved methods of farming was greater than elsewhere.

In Bihar and Orissa, a somewhat different type of concentrated demonstration was initiated in the Ranchi District, an effort being made to carry out demonstrations in every village of one revenue *thana* by means of a special team of *kamdars*. The immediate object was to introduce Dahia paddy and certain other simple improvements in every village of the *thana*, thus producing a mass effect and establishing a local seed supply. It is contemplated that the special demonstrating staff will be able to concentrate on a different *thana* every second year.

DEMONSTRATION TRAINS were run in the Punjab and on the Eastern Bengal Railway in North and East Bengal; in each case all the rural uplift departments contributed exhibits and lecturing and demonstration staff. The Punjab train toured for 6 months

and the Eastern Bengal Railway train for the greater part of the winter period. In both Provinces exhibits and lectures were supplemented by the display of special agricultural cinema films. Apart from the fairly high cost of the Demonstration Train itself, the further extension of this useful method of subsidiary propaganda is apparently limited by the relatively high cost of equipping the train with suitable sets of exhibits and of maintaining these and providing the lecturing and demonstrating staff.

In the Central Provinces a motor-lorry demonstration outfit, complete with exhibits and with an engine, dynamo and full-sized cinema, has been found useful as a self-contained demonstration unit which can reach a number of villages.

In Madras a similar demonstration motor car van, but without the cinema, was at work throughout the year and two more were on order, one having been presented by a Tanjore gentleman for work in the Tanjore and adjoining districts.

There is still some doubt as to the value of the cinema film for demonstrating agricultural improvements and considerations of expenses, in addition to the not inconsiderable difficulty of getting suitable films made, have prevented more exhaustive experiments being undertaken.

II. Agricultural Shows.

Agricultural shows continue to do useful work in most Provinces and vary considerably in size and scope. In Bombay, the Presidency Agricultural Show was held at Ahmedabad in November 1928. This is the second of a series, the first having been held at Poona in 1926. There were also four important district agricultural shows. In other Provinces agricultural shows were held in conjunction with fairs, the demonstrations and exhibits being adapted to local requirements. In Bengal, for example, 24 such shows received grants from Government towards the prize fund, exhibits and magic lantern lectures being supplied by the Agricultural Department. As recommended by the Royal Commission on Agriculture, the Punjab Agricultural Department is trying out the system of a permanent agricultural stall in important markets. The Lyallpur market was selected for the start and the Agricultural

Department's " shop " placed in charge of a whole-time agricultural assistant. The venture promises to be successful for the place was well visited by farmers who attend the market where the Agricultural Association was able to collect some useful information about market customs.

III. Agricultural Associations.

Twenty-five district agricultural associations are reported to be doing useful work in the Punjab and seven such associations in Bengal have been specially commended by the Director of Agriculture as having actively carried out a definite demonstration programme. In the United Provinces seventeen agricultural associations in the Eastern Circle are stated to have done good work. Generally speaking, the tendency is for the old type of agricultural association, where it has not already disappeared, to give place to associations organised on co-operative lines for specific objects. In the Bombay Presidency there were 82 *taluqa* development associations during the year, receiving Government grants totalling Rs. 59,000 for demonstration work. The Divisional Boards of Agriculture reported that 32 were successful and efficient, 39 struggling but deserving of help and 11 moribund. On the whole, the associations have done good work.

In the Central Provinces and Berar seven agricultural co-operative associations were at work in the Southern Division and 27 *taluqa* associations in Berar—all mainly occupied with the supply of seed, manures and implements.

IV. Seed Production and Distribution.

Whilst making several recommendations as to means by which the burden of the Agricultural Department in the *distribution* of pure seed could be lightened, the Royal Commission on Agriculture made it clear that the *production* on an adequate scale of such seed, and the organisation of arrangements for its further multiplication, would for many years remain a most important feature of the work of the Agricultural Departments. The Commission further recommended an increase in departmental seed farms in all Provinces. Hence it is satisfactory to note that in every Province

the arrangements for the production and multiplication of seed of improved crops have been extended and improved. In MADRAS the quantity of seed actually issued from the paddy-breeding stations was sufficient for some 7,000 acres as compared to a total area of about 215,000 acres under improved strains. But by the organisation of private seed farms amongst paddy cultivators some 3 million lbs. of seed was controlled. The area under private seed farms for cotton increased from 6,948 acres in 1927-28 to 12,606 acres in 1928-29.

In BOMBAY special attention has been given to seed farms for cotton. In Gujarat, private seed farms under the departmental supervision now supply pure seed for 100,000 acres annually of the famous Surat 1027 cotton. In the Southern Division seed multiplication of the improved strains of Dharwar-American and Kumpta cottons is undertaken by the co-operative cotton sale societies under the Agricultural Department's supervision. A beginning has been made with the organisation of the cotton-seed supply in Khandesh.

In BENGAL seed of improved strains of rice is multiplied for distribution by small local seed farms. During the year under report there were 220 such centres some of which were run by co-operative banks, some by agricultural associations and some by local landholders; in all they issued 12,000 maunds of seed. In connection with the supply of improved jute seed, the Agricultural Department conducted 2,500 germination tests for the Government selling agent.

In the UNITED PROVINCES the total issue of improved seed from the 174 seed stores, which the department controlled or supervised, amounted to 572,384 *maunds* (including 396,795 maunds of sugarcane sets) of eighteen different crops, wheat, rice, gram, barley and cotton being of importance. Most of this seed was produced on private seed farms (some aided) or by registered seed-growers; departmental seed farms numbered 17 and these provided the very essential nucleus of pure seed for the larger organisation.

In the PUNJAB departmental seed depots handled 54,391 maunds of wheat seed and 42,082 maunds of cotton seed. The various

large private farms in the Canal Colonies were as usual of considerable assistance to the department in seed multiplication.

In BURMA the 18 major seed farms now cover 2,266 acres, some were newly established and not fully at work; the quantity of paddy seed produced was 41,057 baskets of 50 lbs. In addition, there were 69 "grazing ground seed farms," covering 4,246 acres which produced 40,744 baskets; the latter are portions of common land reserved for purposes of seed production for the neighbourhood and rented to local cultivators on special conditions. As the additional Government farms and the local seed farms come into full operation, the supply of improved rice seed will be greatly improved.

In BIHAR AND ORISSA a definite beginning was made in the organisation of registered growers for the multiplication of improved varieties of wheat, sugarcane and other crops, the demand for seed of which had far out-stripped the capacity of the departmental farms.

In the CENTRAL PROVINCES large seed operations were undertaken with rice and wheat in the Eastern Circle where private seed farms increased from 995 to 1,104 for rice and 562 for wheat. In the Western Circle cotton, *juar* and groundnut received special attention. The new Verum 262 cotton was distributed mainly in compact areas and the system of co-operative marketing adopted ensured the seed supply for the coming year, seed farms for groundnuts rose from 987 to 1,289. In the Northern Circle special wheat seed operations were necessary in view of the partial crop failure following the rust attack of 1927-28. Wheat seed to the value of Rs. 4,50,000 was purchased from growers for distribution; these operations led to a great extension in the area under the department's rust-resistant strains which were in keen demand.

In ASSAM three seed depots were maintained but it is reported that the value of their work was discounted by the absence of seed farms.

V. Implements.

In Appendix V will be found a statement of the agricultural implements sold through departmental agency, and the sales of

ploughs are characterised in all Provinces by one satisfactory feature, *viz.*, that sales of spare parts considerably exceed the sales of ploughs—a useful indication that the ploughs are used. The recorded sales are no real measure of the extent to which improved implements have come into use. Both manufacture and sale by private agencies is increasing and departmental sales in some cases represent little more than the first following up of successful demonstrations. In all Provinces the tendency is for the Agricultural Departments to devolve the supply of agricultural implements to other agencies as much as possible and to concentrate on experiment and demonstration. Co-operative organisations, however, have been disappointingly backward in taking up a branch of agricultural supply which can be run on a business footing and which is free from the risks accompanying the storing and supply of more perishable requirements. The total sales of agricultural implements through the Agricultural Department amounted to 41,528 as compared to 35,838 in the previous year and spare parts to 29,848 as compared to 24,240. Plough sales numbered 27,478 compared to 24,604, the largest increase being in the Western Circle of the Central Provinces due to organised demonstrations. Sales of fodder cutters in the Punjab rose from 3,310 to 7,142. Reference to the more recent work on the design of improved implements has been made in another chapter and to propaganda by peripatetic demonstrators in an earlier part of this chapter. Demonstrations at agricultural shows, district exhibitions and fairs, especially ploughing matches and similar competitions organised on these occasions, are still an important method of propaganda.

VI. Fertilisers.

No complete returns are available of the sale of commercial fertilisers and oil-cakes, but the table in Appendix VI gives the ascertained sales by Agricultural Departments' depots. Sales by private agency have always been important and are increasingly so. Reference has already been made to the increasing use of green manures in certain tracts, whilst demonstration and propaganda for the better conservation and utilisation of cattle manure

and other village refuse is steadily being carried on by the various Agricultural Departments as part of their regular programme. That the use of ammonium sulphate in particular has steadily extended during the last few years is clear from the fact that whilst in 1927-28, with a production in India of 18,509 tons in 1927, net exports amounted to 3,756 tons, in 1928-29, with a production of 15,409 tons in India during 1928, there was a net import of 17,983 tons. As already mentioned, sales of the new ammonium phosphate type of fertiliser, especially as manure for rice, both by departmental and private agency, have steadily expanded. It seems not unlikely, however, that there will be a definite check in the use of synthetic nitrogen manures by the average cultivator. The steady fall in the price of all agricultural products, especially of cereal products, which has accompanied world production in excess of effective demand, has removed the incentive to the use of purchased fertilisers which the earlier fall in the price of nitrogenous manures provided. Only in rare instances in India has the standard of production of any crop reached a point where a reduction in gross yield, in order to produce more cheaply, is warranted. But with the general fall in agricultural commodity prices, the cultivator's power to purchase fertilisers has been greatly reduced and other means of improving the efficiency of production must be sought.

The co-operative movement in relation to agriculture forms the subject matter of a separate chapter, but mention should here be made of the fact that in all Provinces a very definite attempt has been made to secure closer collaboration between the Co-operative and Agricultural Departments in all matters relating to agricultural propaganda and demonstration and the supply of such agricultural requisites as seed, manure and improved implements. As the Royal Commission on Agriculture pointed out, it is an enormous advantage to an agricultural department to be able to deal with co-operatively organised bodies of cultivators whatever the primary purpose of the organisation. Apart from the formation of special 'non-credit' societies, it should be possible to make great use of the ordinary credit societies for propaganda purposes. This much is obvious; the details are more difficult but are being solved gradually.

CHAPTER IX.

AGRICULTURAL EDUCATION.

The reports of the Provincial Departments of Agriculture show that the recommendations of the Royal Commission on Agriculture, many of which more directly concern the Education Departments, have received careful attention but that as yet no marked changes in policy have resulted.

I. Agricultural Colleges.

The scheme for an Agricultural Institute at Dacca to work in close harmony with the Dacca University has been revived but progress is again held up by " financial stringency". The Government of Bihar and Orissa authorised the preparation of a detailed scheme for an Agricultural College, which would be affiliated to the Patna University and be of the type recommended by the Royal Commission, but are doubtful of their ability to proceed with the scheme until provincial finances improve. Thus, there are still no facilities for higher agricultural education in the eastern half of India.

During the year the negotiations regarding the affiliation of the Cawnpore Agricultural College to the Agra University were successfully completed and a Faculty of Agriculture established in that University.

The Mandalay Agricultural College is now the only one not affiliated to a University.

The COIMBATORE AGRICULTURAL COLLEGE had 121 students in residence during the year and admitted 41 of 341 applicants to the new session. Twenty-seven students appeared for Part II of the B. Sc. (Ag.) examination of the Madras University and 19 passed. At Coimbatore the teaching and research branches of the College and Research Institute now occupy different buildings and there is complete separation of responsibility for the teaching work of the College and major investigations in agricultural science

But the teaching staff is encouraged to undertake research, whilst research officers assist the College by giving a limited number of advanced lectures in their own subject; eighteen such lectures were given during the year.

The POONA AGRICULTURAL COLLEGE received 220 applications for admission of which 92 were eventually admitted, 15 of these being scholars. As usual a number of applications were received from outside the Province and 10 such candidates were admitted. Seventy-nine students from the College appeared for the B.Ag. degree of the Bombay University, 60 being successful. It is stated that sons and relatives of landholders form a large and growing group in the College.

The CAWNPORE AGRICULTURAL COLLEGE, as noted above, is now affiliated to the Agra University, the first admissions to the degree course being made in July 1930; the first examination for the B.Sc. degree in Agriculture will be held in 1932. The college course is a 4-year one, the first two years being spent in preparation for the intermediate examination. Applications for admission to the diploma course, which will now become the degree course, totalled 175 and 69 students were admitted. The two-year vernacular course continued to be popular; applications numbered 113 and admissions 24. The number of students in residence was 186; additions to the hostels have been necessary recently and these have now been completed. A change in the teaching of practical agriculture was made in order to give students more practical experience; separate plots are now allotted to students on which they raise crops according to a fixed cropping scheme. A new course of instruction in agricultural engineering, dealing with heavy agricultural machinery, for 3rd year students has been added in the curriculum recently.

At the PUNJAB AGRICULTURAL COLLEGE, LYALLPUR, 44 new students were admitted to the degree course and 15 to the two-year certificate course. In addition, 11 students who had passed the F. Sc. (Agri.) examination from the Khalsa College, Amritsar, were admitted to the third year in the degree course. Thirty-six candidates sat for the B.Sc. examination in agriculture of the

Punjab University, of whom 28 passed. The M.Sc. course in agriculture is becoming better known; two students submitted theses for the M.Sc. (Agri.) and four more were admitted to this course.

The NAGPUR AGRICULTURAL COLLEGE was affiliated to the Nagpur University in 1925 and the first examinations for the degree in agriculture were held in March 1929. Of 13 candidates who sat for the final examination, three failed, five were required to be re-examined in plant pathology and five passed. Nor were the results at the Intermediate examination satisfactory, and there were clear indications that students, who were handicapped by a low standard of preliminary education, found the Intermediate course difficult to assimilate in two years. Under present circumstances too much time has to be devoted to the teaching of English and elementary science, and the desirability of introducing a preliminary science examination prior to admission to the Agricultural College is receiving consideration. Admissions to the degree course numbered 36 out of 91 applications; nine admissions were made to the college certificate (two-year) course. The total number of students on the roll was 101, of whom 10 were from Indian States. The hostel accommodation has recently been increased to provide for 135 students, the extension scheme providing for 170 students eventually.

The MANDALAY AGRICULTURAL COLLEGE is not at present affiliated to a University but as stated in last year's Review, the question is to be reconsidered as soon as it is found practicable to raise the standard of admission. There were 43 students in residence at the end of the year. At the examination at the end of the first year only 10 students out of 20 qualified, and of the 10 that failed only two were allowed to repeat the course. Of eleven students in the second year, eight passed the qualifying examination and two were allowed to repeat the course. The wastage at the end of the first year is heavy and was due to inadequate preliminary education but, as the Director points out, it is far better that the necessary weeding-out should take place at this stage than later. He also comments on the poor knowledge of English throughout the College and is taking steps to remedy this. In the final

diploma examination, out of the 12 students appearing ten passed, of whom two obtained a first class.

The ALLAHABAD AGRICULTURAL INSTITUTE (American Presbyterian Mission) continued to give two courses, *viz.*, a two-year course in dairying for the Indian Dairy Diploma and a course in agriculture up to the Intermediate standard.

The HEBBAL AGRICULTURAL SCHOOL, MYSORE STATE, should be mentioned here since it teaches a four-year diploma course in agriculture, English being the medium of instruction—indeed the question of establishing an Agricultural College in Mysore at an early date is now under consideration. The number of students in residence during the year was 44, the highest on record. Seventy applicants sat for the entrance examination in June 1929 and 27 were admitted—a number which was only rendered possible by the provision of temporary hostel accommodation pending the enlargement of the hostel. Nine students sat for the final examination for the diploma, of whom seven were successful.

II. Post-graduate Training in Agriculture.

The Pusa Research Institute continued to offer facilities for higher post-graduate training in the various branches of agricultural science. Post-graduate courses of two years' duration are given in Economic Botany (specialising in Plant-breeding and Genetics), Mycology, Agricultural Chemistry, and Entomology. Facilities were also available for post-graduate training in Agricultural Bacteriology but no student took this subject. Post-graduate students in Animal Husbandry spent most of their time at the Imperial Institute of Animal Husbandry and Dairying, Bangalore, and part of their time in the Agricultural Section at Pusa. Twenty-six candidates applied for admission to the course commencing in November 1928, of whom five were admitted—two in Economic Botany, two in Mycology and one in Chemistry. One more student was subsequently admitted to the post-graduate course in Economic Botany making, with the three students admitted in the previous year, nine in all. In addition, a research student deputed by the Indian Central Cotton Committee completed a

year's training in Entomology, an Entomological Assistant deputed by the United Provinces Department of Agriculture completed a special two-year course in Systematic Entomology and an Entomological Assistant from the Central Provinces was admitted for a special course of a year. Four post-graduate students in Animal Husbandry spent three months in the Agricultural Section at Pusa. One post-graduate student in the Botanical Section who had remained on as a voluntary research worker was appointed Assistant Economic Botanist, Bihar and Orissa, during the year, and subsequently placed in charge of the Botanical Section in the Agricultural Department of that Province. Another botanical student deputed by the Punjab Government was appointed Assistant to the Millet Botanist, Punjab, on completion of his course ; yet another Punjab student was undergoing a special one-year course of training prior to appointment as Oil-seeds Specialist in the Punjab Department of Agriculture.

III. Agricultural Schools.

Reference has already been made to the two-year courses at several Agricultural Colleges which are designed to meet the demand for a shorter and more practical course of instruction in agriculture than the degree course. In addition, there are a number of Agricultural Schools giving what may fairly be termed vocational teaching in agriculture. This type of agricultural instruction was condemned by the Royal Commission on Agriculture mainly on the ground of disproportionate expense. The Governments concerned have re-examined their position but do not appear to contemplate any change in policy ; on the contrary, they consider that there is a definite demand for this class of agricultural instruction which it is the duty of the Agricultural Department to meet, and that, as compared with expenditure on " literary education," the total cost is not exhorbitant.

In BOMBAY six schools of the " Loni " type were at work as in previous years, the number of pupils being 170. An attempt is being made to reduce the cost per pupil by making the schoo l farm self-supporting and by paying the pupils wages for work done

on it. It is stated that this may involve the adoption of a higher age of admission than at present and a new curriculum better adapted to the half-time system.

In the UNITED PROVINCES the Bulandshahr Agricultural School is reported to have had a successful year. Of the 28 students who completed the two-year course during the year, 14 are farming at home, two are starting farms of their own, two have obtained employment in Indian States, two in the Irrigation Department, four in the Agricultural Department, whilst four are seeking employment. Of the 200 applications for admission, 36 were accepted, 31 being from land-owning families and two the nominees of large land-owners. In addition to the 136 pupils who have passed the two-year course, the school has now trained 46 teachers for "agricultural bias" schools, 28 fieldmen and 16 mechanics. The Bulandshahr school is being provided with an additional boarding house. The buildings for the second agricultural school at Gorakhpur were nearing completion.

In MADRAS, the Taliparamba Agricultural Middle School had 44 pupils on the roll at the end of the year. A good course in practical agriculture is given at this school including, in addition to the common crops of the locality, crop rotations for dry lands, poultry farming and elementary dairying; it is claimed that the students leave with a useful training in practical farming. Of the 90 boys who have passed through the school, 70 per cent. are either engaged in farming or in teaching "Nature Study" in schools. The Madura District Board have decided to open a similar agricultural middle school at Usilampatti for the benefit of the *Kallars*; Government have given a substantial grant for the buildings and the Agricultural Department is finding the technical teacher and the manager for the school farm, but the bulk of the cost, however, falls on the District Board. The Director of Agriculture considers that the school cannot fail to be a success.

In the CENTRAL PROVINCES, the Agricultural Anglo-Vernacular School at Hoshangabad is a half-way house between the "vocational" and "bias" types of agricultural school. There were 82 students on the roll in four classes: 52 applications for admis-

sion were received but only 35 could be admitted. Of the 82 pupils, 62 were from the Hoshangabad District itself—the Director of Agriculture remarks that, although known and appreciated in other parts of the Province, the school cannot do more than meet the needs of the Hoshangabad Division.

In BURMA, the aided agricultural school at Pyinmana—a combined vernacular and agricultural school run by the American Baptist Mission—continued to do good work. The object of the school is stated to be " To train boys who come from the farming communities of Burma so that they may take up the business of farming and practise it with success under the conditions met with in the various parts of Burma". All instruction is in the vernacular, the school has a farm of 160 acres and in the garden each student works his own vegetable plot. The school is now in its sixth year and the first class passed out in 1927. The total number of boys who have completed the four-year course is 35 ; of these 16 are working as farmers, four as overseers at the agricultural school, two in the Agricultural Department and five as teachers.

Reference has already been made to the Mysore Agricultural school which approaches to the agricultural college standard. In TRAVANCORE, the Alwaye Agricultural School had 18 students, whilst 30 were admitted to the newly opened school at Kottarakaray : the buildings for a third agricultural school at Koni were under construction.

IV. Rural ' Bias ' Schools.

Rural ' bias ' schools are being increasingly recognised to be an important step towards adapting the educational system to the needs of the rural community, and in the Punjab and United Provinces definite action has been taken to see that teachers are properly trained.

In the PUNJAB, 144 vernacular middle schools are teaching elementary agriculture, 72 of them being provided with small school farms and 72 with school gardens. The Agricultural Department assists with the running of the farms and gardens, and

provides a one-year vernacular course at the Agricultural College, Lyallpur, for the training of teachers: 31 certified teachers took the course during the year.

In the UNITED PROVINCES, there are 29 " middle " schools with agricultural classes in 26 districts. Teachers for these classes are trained by the Agricultural Department at the Bulandshahr Agricultural School; 46 have been trained to date and 44 were under training during the year.

In BOMBAY there are 80 agricultural " bias " schools run by the Education Department but inspected and assisted by the Inspector of Agricultural Schools provided by the Agricultural Department. It is reported that in genuinely rural centres these agricultural classes are popular. Difficulties are reported to have arisen through the passing of the control of these schools to district school-boards and also through the apathy of the educational staff, but especially from the lack of any definite arrangements for training teachers.

In BENGAL, 30 teachers from High Schools and English Middle Schools in different districts were undergoing a two-year course in agriculture at the Dacca Secondary Agricultural School. These teachers on completion of their course will return to their schools to teach elementary agriculture, the local authorities providing the necessary land for school farms. At present five schools are already working the scheme; the idea has caught on and more schools have applied to enter the scheme than can be provided for at present.

In MADRAS, a Committee appointed in the previous year to examine the possibility of introducing agriculture into the curriculum of the secondary and middle schools of the Presidency on the lines adopted in the Punjab practically completed its labours, and is reported to have arrived at the conclusion that Nature Study rather than agricultural teaching should be aimed at.

V. Short Courses.

Short courses in special subjects at experimental and demonstration farms are increasing both in popularity and utility.

In the UNITED PROVINCES a nine-month course in agriculture was given to 12 students at the Nagina district farm. Nine of the students were sons of cultivating zemindars and the other three cultivators who were 'consolidating' their holdings. The necessary boarding house at the farm has been provided by the District Board. As in previous years, a practical course in sugarcane cultivation by improved methods was given at the Shahjahanpur Sugar Research Station ; a hostel is provided on the farm.

In the PUNJAB two vernacular courses in practical agriculture, each of six months duration, were attended at Lyallpur by 41 and 39 students, respectively, including 19 Co-operative Inspectors. At the Gurdaspur farm also two six-month courses were given and were attended by 30 and 32 pupils, respectively, whilst the two similar courses at the Hansi farm were each attended by 15 students. Other courses at Lyallpur included a month's course in rural economics which was attended by 21 officials of other departments. A six-week course for blacksmiths in oil-engine driving and the repair of improved implements was attended by 17 blacksmiths, and three short courses for practical fruit farmers were given in fruit preservation and fruit culture for which 141 applications were received and 74 students admitted.

In BURMA the present policy is to develop the system of a farm school at each central farm or seed farm as rapidly as finances permit. Such schools are at present at work at the Hmawbi and Mahlaing farms, the course being nine months in duration and 10 and 12 pupils respectively being taken. Short courses in special subjects of varying length were given at the Hmawabi, Mahlaing, Tatkon, Allanmyo and Pwinbyu : in all 14 courses attended by 130 cultivators were given.

In the BOMBAY PRESIDENCY a novel land development class of one week's duration was held at Barsi where systematic and practical instruction in the construction of field embankments was given to 84 visitors, including 48 landlords and cultivators, 18 revenue subordinates, 10 *taluqa* development officers and 8 agricultural officers. For the oil-engine driving class for cultivators, 78 applica-

tions were received but only 30 could be admitted ; the class lasts for 3 months and four classes are now held annually.

VI. Adult Education.

In several Provinces the Agricultural Departments have given assistance in connection with the adult education movement. In the United Provinces, there are 32 co-operative adult educational societies, 28 being in the Eastern Circle of which 13 are in the Benares District, 13 in Lucknow District and 6 in Partabgarh. In this Circle the staff of the Agricultural Department delivered a number of lectures to these societies on simple agricultural improvements : practical demonstrations were also given wherever possible.

CHAPTER X.

THE CO-OPERATIVE MOVEMENT AS AFFECTING AGRICULTURE.

It was stated in the last Review that the co-operative movement in at least three Provinces was not in a healthy condition; as might be expected the year under report has been one of consolidation and improvement rather than of extension in most Provinces. Referring to certain societies now under re-construction, in a Province where co-operation is believed to be sound on the whole, the Registrar remarks that they had been "hurriedly started and recklessly financed"—a criticism which doubtless could be applied with justice elsewhere. In most Provinces also the increase in over-due debt is causing anxiety and various special methods of improving collections have been adopted. Bad crops in some areas, and falling prices in others, have increased co-operative societies' difficulties. Hence in most Provinces few new societies have been registered and increased attention has been devoted to the preliminary education in co-operative ideals and methods which must be observed if success is to be achieved. Despite the existence of many weak societies and bad members, the movement is sound at heart and its stability is ensured by the considerable and ever-growing proportion of their working capital which the societies and members themselves own. The growth of reserve funds, of members' paid-up share capital and of members' deposits is very satisfactory in most Provinces. Moreover, the development of the movement has now reached a stage where it has some effect on the general question of agricultural finance. In 1928-29, excluding Burma, there were 69,378 societies with 2,306,300 members and working capital of Rs. 26,57 lakhs as compared to 66,055 societies and 2,202,700 members and working capital of Rs. 24,27 lakhs in the previous year. Working capital went up from Rs. 24 crores 27 lakhs to Rs. 26 crores 57 lakhs, which affords an indication of the relief from usury which the co-operative movement now affords. The provincial reports show that steady progress is being

made in knowledge of co-operative principles, thrift, the application of loans to the purposes for which they are intended and the restriction of loans for non-productive purposes. As in previous years, there is still comparatively little progress to record in forms of co-operative activity connected with production, distribution and purchase : of the 3,051 (excluding Burma) non-credit agricultural societies, the majority are found in those Provinces where the co-operative credit system is highly developed. In all Provinces careful thought has been given to the recommendations of the Royal Commission on Agriculture that the Agricultural Departments should utilise the co-operative organisation more fully, both for propaganda and for the supply of seeds, implements and manures. The reports of both Directors of Agriculture and Registrars of Co-operative Societies bear witness to an increasing degree of co-operation between the two departments and mutual effort to remove difficulties. An indication of the success met with by special organisations is given below, but perhaps more important is the distinct movement in several Provinces for Central Banks to adopt a definite policy and programme of work in all rural-uplift matters. Should the movement develop, it would aid greatly in the utilisation by the agricultural and other beneficient departments, of existing primary societies as organised bodies of agriculturists to whom they can appeal.

Madras. The number of agricultural credit societies has risen from 11,966 to 12,382—an increase of 416—and the membership from 630,298 to 652,285, whilst working capital has increased from Rs. 5,74 lakhs to Rs. 6,17 lakhs. The co-operative societies themselves owned 28·1 per cent. of the nett working capital employed. The year has been largely one of consolidation and the organisation of new societies has been deliberately restricted in order that proper education in co-operative principles may precede registration. The Registrar reports that " a sense of corporate existence in the societies is generally lacking " and that they are looked on purely as loan institutions. An earnest attempt to remedy this defect is being made, one method being to encourage the holding of regular weekly meetings by all primary societies so that all mem-

bers will be familiar with the business of the society. An effort has been made to make the societies more useful to cultivators by speeding up the disbursement of loans. At present it rarely takes less than a month, from the date of the member's application to his primary society, to pay out a loan. The Registrar is convinced that this delay frequently drives cultivators to the local *sowcar;* not only does it discourage thrift deposits but the cultivator's difficulty in obtaining ready money promptly also leads to delay in the repayment of loans. This is a matter which is well worthy of attention in other Provinces also. The Madras co-operative movement has long had a reputation for a high percentage of over-dues. The Registrar shows that this is not altogether deserved but, as a result of a special effort, involving the deputation of most of the audit staff for the purpose for two months, a considerable improvement was effected. Progress was also made in two other directions, *viz.*, an increase in the proportion of short-term loans and the maintenance of a higher percentage of fluid resources by the Central Banks.

LAND-MORTGAGE BANKS increased from 18 to 21 with a membership of 1,674, share capital of Rs. 1,11,185 and working capital of Rs. 8,66,653. Only 8 banks were actively at work: it is hoped that certain technical difficulties will be removed by the formation of the proposed Central Land Mortgage Bank.

PURCHASE AND PURCHASE AND SALE SOCIETIES numbered 127, a reduction of 6, and supplied goods to members worth Rs. 1,55,777 and sold on commission members' produce to the value of Rs. 5,32,463, whilst loans on the pledge of moveable property amounted to Rs. 4,37,329. LOAN AND SALE SOCIETIES numbered 63 and were of two classes—large societies, including four cotton sale societies which are described later, and smaller societies which build, buy or hire a godown in which the ryot can store his produce, get an advance for it and sell at leisure. These smaller societies do not undertake either the grading of produce or joint sale and are merely intended to save the producer from being entirely at the mercy of his creditor. These societies are linked up with village societies already doing a fair business in advancing money

for cultivation. LAND RECLAMATION SOCIETIES numbered 10, an increase of one, and with 565 members, a share capital (paid-up) of Rs. 13,278 and working capital of Rs. 2,06,755, are reclaiming 2,360 acres of land. It may be remarked, however, that the societies paid nothing for the use of the tram-line and tipping wagons lent them by the P. W. D. or for the superviser and mechanic in charge.

IRRIGATION SOCIETIES numbered 9, their object being to install power pumping sets on wells; only one installed plant, the other societies apparently being unwilling to pay for the necessary preliminary investigation by the Industries Department: a not unnatural objection as in the event of the result of the test being negative, they would have had nothing to show for their money. Of eleven "KHUDIMARAMAT" SOCIETIES for the clearing and maintenance of irrigation channels, five did no work.

The number of AGRICULTURAL DEMONSTRATION SOCIETIES—an alternative and more exact title for the "better farming" society—rose from 5 to 16, of which 8 are reported to be really active.

Bombay. In this Presidency there was a small increase in the number of agricultural credit societies from 4,177 to 4,317, but membership decreased slightly from 263,493 to 262,569 and working capital from Rs. 3,53 lakhs to Rs. 3,50 lakhs. A rigorous policy of weeding-out bad societies and improvident members was followed, some unwieldy societies with large membership were reorganised and a cautious policy was followed in regard to new registrations. Some idea of the hold which the movement has now established is shown by the fact that, for the Presidency as a whole, there are co-operative societies in 20·4 per cent. of the villages as compared to 19·5 per cent. last year; in Broach, Dharwar and East Khandesh districts, which lead in this respect, the percentages are 47·9, 45·3 and 38, respectively. Of the working capital, 39 per cent. is now owned by the societies and their members as compared to 36 per cent. last year. Unlike Madras, there is in the Bombay Presidency too small, rather than too large, a percentage of long-term loans and the Provincial Bank was again unable to use its funds fully, no less than a crore of rupees being invested

in Government securities and deposits with joint-stock banks. It is considered that there cannot be very rapid progress in the organisation of new primary societies but that much could be done to finance more adequately members of existing societies, especially selected members. Two steps in particular are contemplated, *viz.*, the more extended finance of produce through purchase and sale unions and long-term advances to selected members for porductive purpose and for the redemption of old debts. It is believed that much can be done in the latter direction provided that separate rules are adopted for long-term loans and full advantage taken of the ability of borrowers to furnish specific security. The Provincial Co-operative Bank has undertaken an experiment on these lines in two districts. Three land-mortgage societies were registered. The number of non-credit societies numbered 251 and societies for the sale of produce 59, of which 28 dealt in cotton and are referred to below, and 10 in paddy. A new type of PURCHASE AND SALE UNION, the membership of which is confined to societies and which could be linked up with the appropriate Central Bank or with the Provincial Bank, was introduced. The advantage of a society membership is that the risk of local *dalals* and middlemen capturing the sale societies is avoided: on the other hand, as the Registrar points out, these unions will need to be very fully and promptly financed, if they are to function successfully. It is contemplated that, as the system of purchase and sale unions extends, the various small supply societies will be linked up or absorbed. FENCING SOCIETIES for the protection of crops from damage by wild animals by fencing numbered 14 with 727 members and erected 25 miles of fencing at a cost of Rs. 46,397. LAND IMPROVEMENT SOCIETIES numbered 10 with 448 members, the total area involved in improvement schemes being 1,883 acres of which 1,207 acres were improved at a cost of Rs. 17,672. These societies mainly finance the building of embankments. A supervising union for the fencing societies has recently been formed. The TALUQA DEVELOPMENT ASSOCIATIONS, which are registered as co-operative societies, form an integral part of the agricultural propaganda organisation of the Presidency; their working has been

fully described in Chapter VIII. Seed distribution by several of the cotton sale societies has been efficiently carried out. In general the Registrar does not consider that the smaller seed societies are entirely successful and considers that the work should be taken over by Purchase and Sale Unions working in close association with the financing Bank.

Bengal. Agricultural credit societies, including grain banks, increased from 15,689 to 16,930 and the membership from 382,152 to 408,980; working capital increased from Rs. 3,77 lakhs to Rs. 4,21 lakhs, "owned" capital having risen to about 1,23 lakhs, and reserve funds having increased from 53½ to 65½ lakhs. As in other Provinces, there was a distinct increase in over-due loans —due, it is said, to lower prices for jute and rice. Special steps to reduce over-dues have been taken as the rise from 29·4 per cent. to 34·4 per cent. is not considered satisfactory. As in Bombay, it is considered that part of the increase in over-dues is due to lack of definite arrangements for long-term loans. Two land-mortgage banks are at present at work. A vigorous policy of weeding-out bad societies was followed and 65 such were placed under liquidation in the Rajshahi Division.

The CO-OPERATIVE IRRIGATION MOVEMENT has made steady progress and in the Burdwan Division there are 758 irrigation societies, an increase of 243, with 130,000 *bighas* under irrigation. Most of these societies have been formed for the purpose of restoring or the re-excavation of old irrigation tanks and reservoirs. A feature of the year was the initiation of a co-operative land colonisation scheme in Chittagong. Under this scheme, co-operative societies of landless agriculturists will be formed who will be given settlement of blocks of Government land on the security of which they will be able to raise money for the reclamation of the land and the stocking of their holdings.

AGRICULTURAL PURCHASE AND SALE SOCIETIES rose from 85 to 100, their membership from 26,867 to 28,982 and working capital from Rs. 18,74,507 to Rs. 37,15,741. More attention was paid to the development and consolidation of existing societies than to new organisations. The most important group was that formed

by the jute sale societies—the Bengal co-operative whole-sale society—which takes charge of all the selling arrangements, maintains two expert managers and an experienced Inspector; the latter constantly visited the individual sale societies and supervised the standard of assortment of the jute.

THE PADDY SALE SOCIETIES. The Central Paddy sale society in Calcutta formed in the previous year and the appointment of a touring Inspector to link up the individual societies stimulated this form of co-operative activity: paddy sale societies in the Burdwan Division increased from 11 to 20.

Co-operative agricultural associations undertaking the supply of seeds, manures and implements, increased from 31 to 32.

The establishment of the BENGAL CO-OPERATIVE SILK UNION gave an impetus to the formation of societies amongst the rearers and reelers of silk, the number rising from 65 to 81. Of these 29 were affiliated to the union and the rest working mainly as credit societies were financed by Central Co-operative Banks.

United Provinces. During the year under report, the number of societies was further reduced from 5,697 to 5,390 and membership from 1,37,000 to 1,27,000. Working capital, however, increased from Rs. 97 lakhs to Rs. 1,03 lakhs. Members' deposits, paid-up share capital and reserve funds have all increased, now totalling Rs. 46,08,765 as against Rs. 44,24,049. As the Registrar points out, the co-operative movement in the United Provinces is still under a cloud but it is intrinsically sound. Reorganisation and consolidation are being steadily pushed on and a vigorous policy of weeding out ineffective societies was pursued. Enquiries under section 35 of the Act were held into the financial conditions of 1,000 societies; as a result 350 were re-organised becoming practically new societies and 250 were given time to improve, whilst orders for liquidation were passed in regard to 400. Total liquidations during the year numbered 390 as compared to 255 in the previous year. Only 119 new societies were registered. Special attention was again devoted to the training of member-secretaries for primary societies. An important event of the year was the formation of the United Provinces Co-operative Union: an administrative body,

replacing the standing advisory committee, which consists of two delegates from each Bank one of whom is a member of a primary society. Through an executive committee which meets monthly, the new union controls the supervisors and lays down general instructions for the work. It is as yet too early to state whether the supervisors' work will be better done under control of the union than when controlled by individual Central Banks. Under the conditions of the year it is natural that there was no great development of non-credit societies. Two non-credit central agricultural supply societies were started, bringing the number up to 5. A co-operative society was also formed for the supply of sugarcane to a local sugar factory and the society received a contract for 50,000 maunds. Societies for the consolidation of holdings languished due to the absence of a trained inspector but some progress was made in one society.

Co-operation with the Agricultural Department was strengthened during the year and intensive demonstration work was taken up in selected areas by working through the Central Banks and existing societies and using the latter as organised bodies of cultivation. In one Circle alone, the co-operative societies in the intensively worked area distributed 7,000 maunds of wheat seed, 35,000 maunds of cane sets and 300 improved ploughs obtained from the Agricultural Department. Ten co-operative Inspectors were given special training at the Agricultural College, Cawnpore, and a number of new co-operative supervisors at the Partabgarh Experimental Farm.

Punjab. The number of agricultural societies increased from 15,299 to 16,473, the membership from 453,133 to 504,907, working capital from Rs. 6,34 lakhs to Rs. 7,31 lakhs, whilst owned capital, in the shape of paid-up share capital, members' deposits and reserve funds, amounted to 36·8 per cent. of the working capital. It will be seen that the membership has now passed the half-million mark; four districts in the Province have 1,200 societies each, so that co-operation is really beginning to affect the life of the average cultivator. The movement is developing healthily; 36,000 new members were added to old societies, proposals for new societies

were received cautiously and emphasis laid on proper education in co-operative principles.

LAND MORTGAGE BANKS numbered 12 with 1,402 borrowers, an increase of one on last year. Of 375 new loans, 218 were for the payment of old debts, 143 for redemption of mortgaged land and 16 for land improvement. The Registrar records numerous instances of abuse and of the application of loans to other purposes than those for which sanctioned. He considers that there is a risk of such banks merely encouraging an increase in indebtedness and considers that they should largely be limited to areas where the value of credit has been well learned in primary societies.

Of non-credit agricultural societies, 115 new SOCIETIES FOR THE CONSOLIDATION OF HOLDINGS were formed; the area consolidated during the year was 48,709 acres in 204 villages involving 7,630 owners. Prior to consolidation this area was divided into 87,942 bits and after into only 14,667 bits. It is rarely possible to give owners single blocks of land for all their holding but the average size of a block was 3·3 acres after consolidation as compared to ·55 acre before. The saving of labour and increase in agricultural efficiency is too obvious to need comment. The Registrar records that little progress has been made in Amritsar and Lahore Districts and ascribes this partly to the naturally litigious character of the proprietors and their hesitancy to surrender present privileges in regard to canal water-supply. It has to be recognised that consolidation of holdings in old canal tracts offers special problems but probably prejudice will give way before a thoroughly organised demonstration of the advantages of consolidation and of the possibility of arranging irrigation channels equitably. For the consolidation of holdings, Government provided and paid for a staff of eight inspectors and 115 sub-inspectors. There can be no doubt that this has contributed most materially to the success of the work for most other Provinces have at one time or another recorded the difficulty of getting co-operative societies to undertake payment for surveys and tests whether in connection with consolidation of holdings, the construction of bunds for irrigation or the installation of power pumps.

BETTER FARMING SOCIETIES for agricultural demonstration numbered 119 with 3,036 members and the Agricultural Department deputed 28 demonstrators (*muqaddams*) to assist them. These societies sold 4,138 maunds of wheat and 964 maunds of cotton seed to their members and 253 implements—apart from direct purchases. A number of societies have also taken up seed-multiplication.

CO-OPERATIVE COMMISSION SHOPS for the sale of agricultural produce numbered 24, with 3,286 individual members and 1,273 society members. The value of the produce sold was Rs. 47 lakhs. The Registrar, however, reports that members were lukewarm in their support of the societies; of the total produce sold only 69 per cent. was the produce of members and 1,385 individual members sold nothing through their shops, whilst 48 per cent. of those who were members of a sale society through their credit societies likewise failed to support it. The binding rule, enjoining sale of all produce through the society, was only once enforced. One difficulty recorded should easily be capable of solution by better organisation. It is reported that the fact that co-operative commission shops do no loan business is a handicap and results in even those cultivators who are members of co-operative credit societies employing the ordinary commission agent who does lend. By real co-operation between the loan and sale societies this difficulty could surely be overcome. It would be a thousand pities if a movement for the better marketing of agricultural produce which started so promisingly and which was commended by the Royal Commission on Agriculture should fail for want of the determination and perseverance which have made other forms of co-operation such a success in the Punjab.

ADULT EDUCATION SOCIETIES have fallen from 107 to 59; seven schools have been transferred to district boards, 47 have been cancelled and 35 are stated to be good.

Bihar and Orissa. During the year under report the number of agricultural societies rose from 7,934 to 8,532, membership from 220,889 to 232,413, working capital from Rs. 2,06 lakhs to

Rs. 2,38 lakhs : paid-up share capital increased from Rs. 11,04,460 to Rs. 12,63,421, reserves by 4 lakhs and members' deposits from Rs. 4,15,000 to Rs. 5,02,000. Expansion was limited to new areas where special propaganda staff is working, consolidation still being the order of the day in the older Central Banks. Here the Registrar points out improvement must be gradual, since in the past many societies were " hastily organised and recklessly financed." There were only 83 grain *golas* with a membership of 27,249 as compared to 87 with 31,836 members last year, but working capital increased from Rs. 3,10,140 to Rs. 3,50,742 and the profit doubled ; the Registrar comments favourably on the success of grain loans in kind. Amongst non-credit societies may be mentioned three irrigation societies with a working capital of Rs. 6,062 and membership of 140 ; these societies have taken up the construction of irrigation embankments.

A feature of work in this Province is the active part taken by Central Banks and Unions in promoting agricultural improvement. Forty-eight Central Banks and unions actively co-operated with the Agricultural Department in agricultural propaganda and the distribution of seeds, implements and manures. Many of the Banks devoted a portion of their profits to agricultural demonstration, several employed full time Kamdars (demonstrators) trained by the Agricultural Department, whilst others made arrangements for Kamdars to be trained, one Central Bank maintaining a whole time agricultural inspector. After very full consultation between the two departments—with each other and with unofficial workers—a definite scheme of work was prepared and the co-operation of all Central Banks invited. Special attention was devoted to the simplification of procedure when members of primary societies required loans for the purchase of seeds and implements which were to be supplied by or through their Central Bank.

LAND IMPROVEMENT SOCIETIES advanced Rs. 88,000 to members, of which Rs. 31,000 was for the reclamation of waste land, Rs. 18,000 for sinking wells, Rs. 25,000 for earthenwork and Rs. 14,000 for embankments. Two Central Banks are systematically pushing the construction of irrigation weirs in society villages.

Central Provinces and Berar. The number of primary agricultural credit societies fell from 3,891 to 3,787 and membership from 61,559 to 57,320, of whom only 50,265 were borrowing members, but working capital increased from Rs. 1,62,09,459 to Rs. 1,62,46,777 and recoveries from Rs. 31,50,478 to Rs. 33,34,910. The number of primary agricultural societies conducting seed operations was 100 as last year, but a second year's failure of crops practically stopped operations.

AGRICULTURAL ASSOCIATIONS with limited liability increased from 15 to 20, membership from 1,143 to 1,227, paid-up share capital from Rs. 45,537 to Rs. 48,150, sales from Rs. 57,767 to Rs. 1,07,813 and profits from Rs. 3,568 to Rs. 12,930. One association with limited liability and 11 members and a paid-up share capital of Rs. 1,470 for the production and supply of pure seed and the supply of agricultural implements, etc., also worked satisfactorily. CO-OPERATIVE *adhat* (commission) SHOPS increased from four to five with a membership of 584; four are making progress. Four AGRICULTURAL UNIONS existed as before for the production and distribution of pure cotton-seed. Central Banks have taken a more active part than formerly in agricultural demonstration work.

Assam. Agricultural credit societies increased in number from 1,119 to 1,232, membership from 48,117 to 52,924 and working capital from Rs. 22,47,285 to Rs. 25,87,935. There has been a further increase in over-dues which stood at 32·8 per cent. as compared to 27·3 per cent. in the previous year, and the Registrar comments on the steady increase from 17·6 per cent. since 1915-16 as a sign of deterioration. Owned capital, however, has increased to 34 per cent. There were three land mortgage banks but only a small portion of the loans seem to have gone to benefit agriculturists.

North-West Frontier Province. Agricultural credit societies increased from 50 to 89, membership from 1,400 to 2,500, working capital from Rs. 1,10,071 to Rs. 2,12,670. The percentage of recovery of loans was 74·91 per cent. which is very high. Work is practically limited at present to three *tahsils* but progress

has been steady and healthy, and the Registrar records that a sound foundation, in the form of proper instruction in the principles of co-operation, has been laid.

Delhi. With a net increase of three there are now 236 agricultural societies in the Delhi Province with 5,011 members as compared to 4,672 in the previous year; working capital rose from Rs. 6,22,272 to Rs. 7,47,670. The one society for the consolidation of holdings successfully consolidated 281 acres reducing 520 plots to 128 and raising the average area per plot to 2·2 acres from ·54 acre; other advantages were that an additional 16 acres has become irrigable and five wells are under construction. A dozen applications have been received from neighbouring villages.

Burma. The Co-operative Department was engaged throughout the year with liquidation work so that there could be no question of extension. The resolution of the Burma Government on the Committee on Co-operation in Burma, the Chairman of which was Mr. H. Calvert, C.I.E., I.C.S., showed that of 3,800 primary agricultural societies 1,400 were in liquidation. The recommendations of the Committee have been generally accepted by Government and the necessary measures of re-organisation commenced. The Registrar remarks in his report that the history of the co-operative movement in Burma indicates that in its earlier years it attracted quite a large amount of reasonably competent assistance from persons of local standing and influence but that since 1921 such has not been forthcoming in the same volume. Dearth of local leadership, and the demoralisation consequent on the formation of primary societies without any true co-operative basis and their subsequent liquidation, will for some time be serious obstacles to the extensive recovery of the movement. Agricultural credit societies at the end of June 1929 numbered 2,949 as compared to 3,901 in the previous year: other agricultural societies (excluding unions) 422 as compared to 457. Cattle insurance societies numbered 376 as compared to 389. It is stated that despite the depressed state of co-operation in the Province generally, there are many societies which are quite sound, notably most of the societies in Prome District, some groups of societies in Pegu, Tharrawaddy,

Mandalay and Shwebo Districts and a few individual societies elsewhere. The majority of societies had already got into a state past remedy and further heavy reductions in numbers during the next two years must be expected. The Calvert Committee recommended the winding up of the Burma Provincial Co-operative Bank; the local Government decided to accept responsibility for making good the deficit in the Bank's assets to the extent required to pay depositors and that the Bank should gradually wind up its affairs, the Registrar meantime being the sole Manager of the Bank.

RELATIONS WITH THE AGRICULTURAL DEPARTMENT. Despite the unfavourable circumstances of the year, the Deputy Directors of Agriculture were able to record a number of instances of successful co-operation with co-operative societies and many more of co-operation with leading members of individual societies. In two Circles (the Northern and West Central) 54 seed farms for improved paddy covering 748 acres were worked by co-operative societies or their members and the Legaing Co-operative Rice Mill in Minbu District assisted to extend the area under the improved paddy Ngasein 10. In the Irrawaddy Circle, individual members of 15 societies purchased pure seed and improved ploughs from the Agricultural Department and two societies started bulk purchases of seed for distribution to members.

Co-operative Cotton Sale Societies.

Co-operative societies for the sale of cotton continued to prosper in Bombay, have made a start in Madras but have made no progress in other Provinces. The number of co-operative sale societies in the BOMBAY Presidency was 28, of which seven were in the Southern Division, one in Khandesh and the rest in Gujarat. In the Southern Division, the Gadag and Hubli societies as usual were much the most important. The Gadag society had a reserved area of 11,000 acres under selected seed for seed-distribution purposes as against 8,000 acres the year before. Five public auction sales were held and 54,230 maunds of cotton sold valued at nearly 9 lakhs of rupees as compared to 39,918 maunds worth less

than 6 lakhs last year. The society distributed 764,360 lbs. of seed for sowing purposes. Its relations with the local cotton trade were cordial. The Hubli society sold only 53,573 maunds of cotton to the value of Rs. 7,35,000 as compared to 82,248 maunds valued at Rs. 10½ lakhs last year—the difference was due to several causes and the society worked well and expected to recover all lost ground the next year. These two societies occupy a unique position : for many years they have co-operated whole-heartedly with the Agricultural Department in the multiplication and distribution of improved cotton seed and have done a great deal to extend two improved strains throughout the Division having also rendered substantial help to the smaller sale societies. In Bijapur District, two cotton sale societies at Bijapur and Bagalkot covered the district—a new society at Bail Hongal has done good work in seed distribution and grading produce.

In Broach District the Hansot cotton sale society did well, whilst societies in the Surat District handled ginned-cotton and seed worth 19½ lakhs of rupees. The Sonsek co-operative ginning society added six more gins to its equipment and ginned 53,556 maunds of *kapas* during the season. The Kareli society ginned 5,032 maunds.

In MADRAS the four large cotton sale societies facilitated the sale of cotton by providing godowns to store the produce of members, advancing money on it, and arranging for ginning, grading and sale. They are also intended, in conjunction with the Agricultural Department, to distribute and recover pure-strain seed produced in the first instance by the department. The Bellary Loan and Sale Society formed for the purpose took over the auction sales previously conducted by the Agricultural Department with successful results.

Mention should also be made of one PUNJAB society, *viz.*, the Okara zemindars sale society which with 28 members—all large farmers—handled produce, of which cotton was the most important item, valued at Rs. 11,94,000. Such societies are as exceptional as the holdings here represented but the Okara society is a very successful example. Recognising the great possibilities of co-

operative organisation for the marketing of pure cotton in the Punjab, the Indian Central Cotton Committee offered a substantial grant to assist the preliminary organisation of societies for the sale of pure Punjab-American cotton.

Co-operative Cattle-Breeding and Milk Societies.

Co-operative cattle-breeding and milk societies continue to do well in the Punjab and Bengal and considerable expansion has taken place in the latter Province, the number of milk societies having increased from 123 to 169 during the year. Milk Unions are in a thriving condition in Bengal and Madras and have done much to improve urban milk supplies.

Cattle-breeding societies are not so easily managed and are far from perfect, but there are now 163 of these societies in the Punjab and these continue to do good to the live-stock industry, by encouraging the use of better bulls and the castration or removal of inferior males.

They are also of considerable value to Provincial Veterinary Services in popularising veterinary aid.

In Madras, there were 43 registered milk supply societies of which 42 were in the vicinity of Madras city at the end of the year under review, 22 of which were newly created. Though 11 had not commenced operations, the output of milk by these societies had much increased and Government has been asked for a loan to set up a pasteurization plant.

In the Punjab, there are still 14 milk recording societies but it is difficult to sustain interest, though the striking variations in yield recorded by these societies, among indigenous cattle of the same and different breeds, should serve to demonstrate very clearly the practical value of milk recording to dairy men in this country.

Cattle Insurance.

Cattle insurance societies have not increased in number and do not appear to be thriving anywhere.

CHAPTER XI.

PUBLICATIONS OF THE AGRICULTURAL DEPARTMENTS.

A complete list of the agricultural publications issued during the year under review is given in Appendix XIII (page 228). With the formation of the Imperial Council of Agricultural Research in July 1929, the publications previously issued by the Imperial Department of Agriculture have been taken over by the Research Council. During 1930 the existing series of publications continue but from January 1931 the following changes take place. Two new scientific journals, *viz.*, the 'Indian Journal of Agricultural Science' and the 'Indian Journal of Veterinary Science and Animal Husbandry' replace the "Pusa" Memoirs and Bulletins; these journals will also have abstract sections in which will be published abstracts of experimental work published in the various Provinces, especially in experimental farm reports. A series of special monographs, however, will be retained for the publication of material requiring a special *format.* For quarter-of-a-century the Pusa Memoirs and Bulletins have been the principal medium for the publication of the scientific work of both the Imperial and Provincial Departments of Agriculture and Veterinary, and they have established a reputation outside India. But it has been felt for some years that some change in the form of publications was desirable, and it is hoped that the new journals referred to above will prove of benefit to all concerned with the improvement of Indian agriculture. The 'Agricultural Journal of India' and 'The Journal of the Central Bureau for Animal Husbandry and Dairying' will be replaced by the new combined journal "Agriculture and Livestock in India" which will appear in alternate months in 1931 and probably monthly thereafter.

Publications of the Imperial Department of Agriculture during the year numbered 22 Memoirs, 20 Bulletins and four other publications, whilst 19 publications were in the press at the end of the year. A reference to the detailed list in Appendix XIII will show the wide

range of subjects covered by these publications and their practical application. Most of these publications deal with completed investigations the results of which have been discussed elsewhere in this Review. As usual most of the scientific work carried out in the various Provinces was published in the Pusa series of Memoirs and Bulletins. The Agricultural Journal of India appeared bi-monthly and the Journal of the Central Bureau for Animal Husbandry and Dairying in India quarterly ; both continued to maintain their popularity.

Provincial publications. The Madras Department of Agriculture continued the publication, in English and the principal vernaculars of the Presidency, of the monthly digest of the operations of the department. Over 87,000 copies of the ' Villager's Calendar,' published in five languages, were distributed and sold. Leaflets and bulletins numbered nine and six respectively, the usual size of the edition for a leaflet being 20,000 copies.

In Bombay, nine bulletins and fourteen leaflets, the latter in both English and the appropriate vernaculars, were issued during the year.

In Bengal, six leaflets embodying practical recommendations were published during the year under report.

In the United Provinces, bulletins on the control of sugarcane mosaic, and the cultivation of broom-corn, were issued and also a report on the preliminary agricultural survey of the Almora District.

The Punjab Agricultural Department continued to publish " Seasonal notes " half yearly and issued 11 agricultural leaflets. Reference should also be made here to the some recent and valuable publications of the Punjab Board of Economic Enquiry (Rural Section) *viz.* :—No. 11, The Size and Distribution of Cultivators' Holdings in the Punjab, by H. Calvert, C.I.E., I.C.S. No. 16.—Punjab Village Surveys, No. 1.—Gaggar Bhana, a village in the Amritsar District of the Punjab. *Inquiry conducted by S. Gian Singh, B.Sc., under the supervision of C. M. King, C.S.I., C.I.E., I.C.S.* No. 17. - Punjab Village Surveys, No. 2—Gijhi, a village in the Rohtak District of the Punjab. *Inquiry conducted by Raj*

Narain, M.A., under the supervision of Professor Brij Narain, M.A. No. 18. - Punjab Village Surveys, No. 3.—Tehong, a village in the Jullundur District of the Punjab. *Inquiry conducted by Anchal Dass Kandola, B.A., under the supervision of H. Calvert, B.Sc., C.I.E., I.C.S.* No. 19.—Farm Accounts in the Punjab, 1926-1927, by H. R. Stewart, I.A.S., and Ch. Karm Rasul, B.Sc. No. 20.—Farm Accounts in the Punjab, 1927-28, by H. R. Stewart, I.A.S. and S. Kartar Singh, B.Sc.

The Bihar and Orissa Agricultural Department issued ten agricultural leaflets in English and the three vernaculars of the province and one bulletin—all dealing with recommended agricultural improvements.

The Burma Agricultural Department published an agricultural calendar, of which nearly 7,000 copies were sold, five leaflets and one bulletin. Two more reports on Agricultural Surveys were also published, *viz.*, the "Coconut survey of the coastal areas of the Arakan, Irrawaddy and Tenasserim divisions" and "The supply of plough cattle in Burma."

The Assam Agricultural Department published two bulletins and five cultivators leaflets.

CHAPTER XII.

RECEIPTS AND EXPENDITURE OF THE AGRICULTURAL AND VETERINARY DEPARTMENTS.

The total expenditure incurred by the Imperial Department of Agriculture during the financial year ending 31st March, 1929, was Rs. 15,54,813. The gross receipts of the Pusa Institute from the sale of farm produce, cattle, milk, etc., and subscriptions to the Sugar Cable Service amounted to Rs. 88,511 and the receipts from the three dairy farms and one creamery to Rs. 3,51,448. The net expenditure incurred by the Imperial Department was thus Rs. 11,14,854 as compared to Rs. 10,25,464 last year.

	Rs.
General expenditure of the Imperial Institute of Agricultural Research (including the office of the Agricultural Adviser and Director)	2,64,285
Botanical Section	52,256
Chemical Section	1,05,408
Bacteriological Section	43,268
Mycological Section	47,723
Entomological Section	77,362
Agricultural Section	1,47,068
Sugar Bureau	30,807
Sugar Cable Service	20,325
Imperial Dairy Expert	57,690
Physiological Chemist	41,955
Sugarcane Expert	79,768
TOTAL	9,67,915

The receipts and expenditure of the three Dairy Farms and one Creamery under the control of the Imperial Dairy Expert were Rs. 3,51,448 and Rs. 5,86,898, respectively, for the financial year 1928-29.

Name	Receipts	Expenditure
	Rs.	Rs.
Bangalore	1,14,701	1,73,564
Wellington	82,738	1,28,413
Karnal	74,214	1,55,524
Anand Creamery	79,795	1,29,397
TOTAL	3,51,448	5,86,898

The following tabular statement shows the receipts and expenditure of the Provincial Departments of Agriculture for the year 1928-29. The respective figures for the previous year were Rs. 24,57,444 and Rs. 1,24,88,294.

Name	Receipts	Expenditure
	Rs.	Rs.
Bombay	2,92,400	18,28,300
Madras	3,04,727	18,35,359
Bengal	1,60,411	11,21,619
Bihar and Orissa	1,67,216	5,84,943
United Provinces	4,45,921	25,22,714
Punjab	7,09,133	27,56,109
Burma	1,15,856	9,40,958
Central Provinces	3,82,130	11,95,679
Assam	82,587	3,84,417
North-West Frontier Province .	24,676	69,698
Baluchistan	10,836	19,262
TOTAL	26,95,893	1,32,59,058

A further rise of eight lakhs in the total expenditure of Provincial Agricultural Departments, the same figure as in the previous year, is encouraging. Substantial increases are shown by Bombay, Madras, Bengal, the United Provinces, Burma and especially the Punjab. Unfortunately financial stringency threatens to check further advances and in some Provinces even to lead to the withdrawal of existing forms of assistance to the agriculturist. This is to be regretted, and it is to be hoped that essential agricultural services will not be crippled. The present agricultural depression, caused by a world-wide collapse in the price of agricultural commodities, calls above all for increased efficiency in production. High-yielding varieties of crops and better methods of cultivation have a more important part than ever to play in the prosperity of the cultivator.

RECEIPTS AND EXPENDITURE OF THE VETERINARY SERVICES.

Name	Receipts	Expenditure
	Rs.	Rs.
India—General, mainly Imperial Institute of Veterinary Research, Muktesar, and its Izatnagar Sub-Station	14,90,996	7,53,656
Baluchistan	3	77,635
N. W. F. P.	..	65,730
Burma	5	..
TOTAL .	14,91,004	8,97,021
Provincial Governments.		
Madras	26,730	10,32,261
Bombay	10,974	5,17,634
Bengal	1,73,348	5,44,547
U. P.	98,451	4,55,281
Punjab *	2,09,720	14,62,664
Burma	1,383	6,41,996
Shan States Federation . . .	1,465	8,642
Bihar and Orissa	1,04,151	4,30,260
Central Provinces	1,386	4,38,743
Assam	38,361	1,32,298
Coorg	65	14,060
TOTAL .	6,66,034	56,78,386
GRAND TOTAL .	21,57,038	65,75,407

* Including Breeding Operations.

APPENDIX I.

Areas under new and improved varieties of crops during 1928-29.

Name of Province	Name of crop	Advantages	Area in Acres						Remarks
			1928-29			1927-28			
			Departmental seed	Natural spread	Total	Departmental seed	Natural spread	Total	
(a) British India.									
Madras	Paddy	Better yielders and more profitable to cultivators.	18,082	197,849	215,931	11,392	91,065	102,457	
	Sugarcane		1,256	8,584	9,790	3,286	5,521	8,807	
	Cotton		81,340	344,128	425,468	48,968	266,880	315,348	
	Miscellaneous		14,844	157,728	172,572	11,776	44,188	55,959	
Bombay	Cotton—								
	1927 A. L. F.	Lint fetches a premium of Rs. 15-25 per candy (798 lb.).	225,000	250,000	475,000	200,670	240,000	440,670	
	Neglectum roseum	Early ripening; avoids frost; yields more per acre.	16,379	200,000	216,379	9,243	200,000	209,243	
	Dharwar No. 1	Uniform staple, higher ginning percentage, resistant to red leaf.	77,510	12,500	90,010	156,099	..	156,099	
	Gadag No. 1		76,906	62,500	139,406	58,310	43,700	102,010	
	Punjab-American 4-F. and 285-F.	Prolific, hardy, early, commands a premium.	14,000	21,471	35,471	1,420	38,016	39,436	
	Desi 27 W. N.	Prolific, special rough feel, bright colour, higher ginning percentage.	8,000	52,000	60,000	8,715	40,000	48,715	
	Wagad	Superior to local Lalio, fetching Rs. 10 more per candy.	607	..	607	..	..	..	
	Banila (Dhulia No. 1)	Higher ginning percentage, staple superior, fetches Rs. 20 more per candy.	8,000	12,000	20,000	..	..	..	
	Total Cotton	....	426,402	610,471	1,036,878	434,457	561,716	996,173	

	Groundnut	Early maturing, profitable rotation crop.	7,385	420,380	427,765	497	362,796	363,293
	Sugarcane (Red Mauritius and Manjav).	Higher yield of cane and *gur*, do not lodge, free from red rot.	313	2,200	2,513	282	2,350	2,632
	Bajra (Akola)	Better quality grain and higher yield.	1,668	..	1,668	2,148	..	2,148
	Wheat (Pusa 4 and Buxi).	Better yield and less affected by smut	1,983	27,701	29,684	1,578	14,500	16,078
	Paddy (selected strains of Kolamba).	Higher yielding capacity	3,140	14,265	17,405	5,400	..	..
	Miscellaneous	....	836	277	1,113	437	805	1,242
Bengal	Paddy (Indrasail, Nagra, Dudshar, Kataktara, Jhingasail, Charnock, Surjamukhi).	Capable of largely increased yields as compared with local paddy.	10,518	174,737	185,255	5,590	127,897	133,487
	Jute (D. 154, Chinsura Green and K. B.)	Heaviest Yielding types	54,478	1,083,127	1,137,605	45,476	827,989	873,465
	Sugarcane (Tanna and Co. 213).	Drought-resistant; resists water-logging, jackals and pigs; free from disease.	8,041	58,978	67,019	6,802	42,509	48,811
	Other crops	More profitable to cultivators	839	3,009	3,848	388	1,082	1,465
United Provinces	Wheat (Pusa 4, 12, 52, 54, 100, 110, Punjab 8-A, C. 13, 46, Muzaffarnagar, etc.)	High yielding and rust resisting; not liable to lodge as *desi* varieties.	90,000	1,300,000	1,390,000	65,000	1,050,000	1,115,000
	Cotton (J. N. 1, K. 22, A. 19, A. W. F., C. 204, 520, 1031 and 1035, American Cotton, etc.).	Superior to *desi* cotton; better lint and higher ginning percentage.	15,000	200,000	215,000	10,000	200,000	210,000
	Sugarcane (S. 48, Co. 205, 213, 214, 290, Uba, Barbados, Mauritius 16, etc.).	Give more outturn of cane per acre and 50 per cent. of *gur* more than the local varieties.	10,000	271,000	281,000	10,000	125,000	135,000
	Barley (Ballia, etc.)	Better yielder than local varieties	8,000	22,000	30,000	27,000	9,000	36,000
	Gram (Pusa yellow, black, etc.).	Produce and quality better than local varieties.	15,000	33,000	48,000	24,000	22,000	46,000
	Miscellaneous (Jaunpur maize, Cawnpore Dudania *juar*, awned *bajra*, large Japanese and Virginian bunch groundnuts, jute, rice, etc.).	Better yielders than local varieties	61,000	75,000	136,000	44,000	38,000	82,000

Areas under new and improved varieties of crops during 1928-29—contd.

Name of Province	Name of crop	Advantages	Area in Acres						Remarks
			1928-29			1927-28			
			Departmental seed	Natural spread	Total	Departmental seed	Natural spread	Total	
Punjab	Cotton—								
	American 4 F.	Long stapled variety, yields more than *desi* cottons and fetches a premium of Rs. 3-6 per maund of seed cotton.	153,020	820,050	973,070	188,566	536,744	725,310	
	American 285 F.	Spins finer than 4 F. and also more drought-resistan and earlier.	..	100	100	1,860	3,740	5,600	
	Desi No. 24	Improved *desi* variety	61,330	308,260	369,590	65,147	201,113	266,260	
	White-flowered neglectum.	More yield and higher lint percentage	23,505	158,205	181,710	25,540	110,120	135,660	
	TOTAL COTTON	....	237,855	1,286,615	1,524,470	281,113	851,717	1,132,830	
	Wheat (Punjab 11, 17, 8-A, Pusa 4, 12).	More yield, fetch better price, possess good milling and baking qualities, ripen early.	95,125	2,004,405	2,099,530	37,606	1,821,704	1,859,310	
	Sugarcane (Bihar, Co. 205 and 223).	High yield	5,239	78,079	83,318	3,748	22,055	25,803	
Burma	Paddy	Higher yield, freedom from red grain and higher milling outturn.	123,895	199,230	323,125	148,473	170,527	319,000	
	Groundnut	High oil capacity, early maturity, good yield, easy to harvest.	1,055	12,928	13,983	1,106	24,251	25,357	
	Cotton (Indigenous selection and Cambodia).	Longer and finer staple higher ginning percentage.	4,520	2,050	6,570	4,497	745	5,242	
	Gram	Immunity to wilt disease and higher yield.	8,095	147,021	168,116	10,720	131,923	142,643	

Bihar and Orissa	Paddy—							
	Dahia	Early prolific yielder, suitable for uplands.	1,047	12,744	13,791	1,206	23,552	24,758
	Kakharua, Badshabhog, Buromal, Cuttack Nos. 1, 2, 3, 5, Latisail, etc.	Prolific yielders	1,631	4,829	6,460			
	Sugarcane (Co. 205, 210, 213, 214, M. 2).	Greater outturn in cane and sugar	1,366	44,722	46,088	1,154	..	..
	Groundnut (No. 17)	Profitable crop even on poor land	47	2,560	2,607	97	1,698	1,795
	Tobacco (Pusa 28)	Heavy yield and suitable for local consumption.	25	215	240	10	150	160
	Gram (Sabour No. 4, Pusa No. 17).	Heavy yield	96	301	397	170	257	427
	Wheat (Pusa 4, 12, 100, 52, 80-5).	Greater yield	819	4,879	5,198	153	1,845	1,998
	Miscellaneous (Pusa Linseed 12, Sabour Peas 510, Dhaincha, Elephant grass).	....	84	54	138	10	8	18
Central Provinces	Wheat	Better yielders	..		269,907	..	..	195,171
	Paddy		..		181,696	..	..	163,364
	Cotton		..	..	627,671	..	..	469,144
	Juar (Sorghum)		..	..	129,778	..	..	108,077
	Groundnut		..	..	75,024	..	..	49,554
	Other crops		..	..	20,187	..	..	7,828
Assam	Paddy	Higher yielders than *desi* varieties	596	11,966	12,562	835	9,755	10,590
	Jute		514	5,546	6,060	515	4,375	4,890
	Sugarcane		116	3,128	3,244	141	2,810	2,951
	Potato		249	2,482	2,731	1,545	2,078	3,623
North-West Frontier Province.	Wheat (Pusa 4)	Ripens early, yields well, does not lodge, resists rust.	..	..	330,500	..	..	330,000
	Sugarcane (Red Assami)	Ripens early, is vigorous and little affected by diseases and insects.	..	..	620	..	..	600
	Berseem	Yields better than shaftal and is less liable to cause hoven.	..	..	12,000	..	..	12,000
	Fruits	Superior varieties	..	..	3,100	..	..	3,000
	Maize	Ditto	..	..	6,020	..	..	6,000

Areas under new and improved varieties of crops during 1928-29—concld.

Name of Province	Name of crop	Advantages	Area in Acres						Remarks
			1928-29			1927-28			
			Departmental seed	Natural spread	Total	Departmental seed	Natural spread	Total	
		(*b*) Indian States.							
Name State—									
Hyderabad .	Cotton-Gaorani, Gadag I, Dharwar 1.	....	..	..	94,500	..	..	..	
Mysore . .	*Ragi*-H. 22, H. 40 and H. 2.	Pedigree seeds obtained by plant selection; give about 30 per cent. more grain than local mixtures.	1,019	..	200,000	..	..	..	
	Ragi—H. 41 and H. 42 (for irrigated fields).	Give nearly 50 per cent. more yield							
	Paddy—G. E. B. 24 .	Gives good yields of fine paddy . .	1,841	..	20,000	..	..	..	
	Cotton—Selection 69 .	Gives better and more lint than the local variety.	84	..	15,000	..	..	..	
	Sugarcane (seedling canes)—H. M. 320, H. M. 544, H. M. 553, H. M. 602, H. M. 544 striped.	Yield heavy tonnage of canes and very good *jaggery*.	709	..	6,000	..	..	..	
	Groundnut—H. G. No. 1 (Hebbal Groundnut No. 1).	An erect variety which ripens a fortnight earlier than the spreading types. Resists drought and leaf spot disease to a great extent. Yields more than Small Japan and Spanish.	2,059	..	7,467	..	..	..	
Baroda . .	Rice . .	....	250	..	..	..	..	..	
	Cotton . .	....	14,250	..	..		..	..	
	Wheat . . .	....	60	..	..	..	..	..	
Travancore . .	Paddy . . .	Early prolific varieties . . .	438	..	..	352	..	..	

| | | |

APPENDIX II.

List of Agricultural Stations in 1928-29.

Province	Agricultural Stations	Area in Acres	Officer in immediate charge	Supervising Officer	REMARKS
			(*a*) **British India.**		
Imperial Department of Agriculture	Pusa	800	Overseer	Imperial Agriculturist.	
	Bangalore	291	Superintendent	Imperial Dairy Expert	Dairy farms.
	Wellington	115	Ditto		
	Karnal	2,154	Ditto		
	Coimbatore	90	Farm Manager	Government Sugarcane Expert	Imperial Sugarcane Station.
Madras	Coimbatore	314	Ditto	Principal, Agricultural College	Central farm attached to the Agricultural College.
	Samalkota	57	Ditto	Deputy Director of Agriculture, I Circle, Vizagapatam.	
	Anakapalli	36	Ditto		
	Guntur	150	Ditto	Deputy Director of Agriculture, II Circle, Guntur.	
	Hagari	225	Ditto	Deputy Director of Agriculture, III Circle, Bellary.	
	Nandyal	88	Ditto		
	Palur	64	Ditto	Deputy Director of Agriculture, IV Circles, St. Thomas Mount.	Groundnut station.
	Palakuppam	16	Ditto		
	Koilpatti	125	Ditto	Cotton Specialist, Coimbatore	Cotton breeding station.
	Kasargod	106	Ditto	Deputy Director of Agriculture, VII Circle, Tellicherry.	West Coast coconut station.
	Taliparamba	86	Ditto		
	Vellalore	2	Ditto	Deputy Director of Agriculture, VIII Circle, Coimbatore.	Betel Vine station.
	Nanjanad	36	Manager	Curator, Government Botanic Gardens, Ootacamund.	Seed potato farm.
	Coonoor, Burliar and Kallar.	..	Assistant Manager		Pomological station.

Bombay	Chintaladevi	850	Manager	Deputy Director, Live-stock, Hosur.	Cattle farm.
	Guntur	150	Ditto		Buffalo breeding station.
	Hosur	1,635	Ditto		Central cattle farm.
	Surat	298	Superintendent	Deputy Director of Agriculture, Gujarat, Surat.	Cotton and *juar* research station.
	Amalsad	19	Agricultural Overseer		Sugarcane farm.
	Nadiad	45	Tobacco Breeder		Tobacco farm.
	Broach	27	Cotton Breeder, South Gujarat.		Cotton and *juar* farm.
	Dohad	68	Superintendent		Cotton farm.
	Viramgam	6	Cotton Breeder, North Gujarat.		Wagad cotton breeding farm.
	Dhulia	29	Headmaster, Vernacular Agricultural School.	Deputy Director of Agriculture, North Central Division, Nasik.	Cotton breeding farm and Vernacular Agricultural School.
	Sangvi	49	Manager		Cattle breeding farm.
	Jalgaon	205	Superintendent		Seed farm.
	Kopargaon	111	Ditto	Deputy Director of Agriculture, South Central Division, Poona.	Sugarcane station.
	Baramati	21	Ditto		Sugarcane farm.
	Manjri	67	Ditto		Sugarcane experimental station.
	Mohol	55	Overseer		Dry farming station.
	Dharwar	150	Superintendent	Deputy Director of Agriculture, Southern Division, Dharwar.	
	Gokak Canal (Arbhavi)	62	Ditto		Rice breeding farm.
	Mugad	9	Ditto		Cattle breeding farm.
	Tegur	870	Fieldman		
	Chharodi	2,279	Manager	Live-stock Expert to Government, Bombay, Poona.	Kankrej cattle breeding farm.
	Bankapur	256	Ditto		Amrit Mahal cattle breeding farm.
	Ratnagiri	94	Superintendent	Deputy Director of Agriculture, Konkan, Ratnagiri.	Rice and *nagli* breeding farm.
	Kumta	22	Ditto		Rice breeding farm.
	Karjat	9	Rice Specialist		Rice Research station.

List of Agricultural Stations in 1928-29—contd.

Province	Agricultural Stations	Area in Acres	Officer in immediate charge	Supervising Officer	Remarks
Bombay —*contd.*	Karjat	6	Superintendent	Crop Botanist to Government Bombay, Poona.	Rice breeding station.
	Kirkee	4	Ditto		Wheat breeding station.
	Karachi (Willingdon cattle farm).	800	Manager	Deputy Director of Agriculture, Sind, Karachi.	Sindi cattle breeding farm.
	Mirpurkhas	200	Superintendent		Cotton breeding farm.
	Mirpurkhas	60	Horticulturist (Sind)		Fruit farm.
	Sukkur	30	Superintendent		Buffalo breeding farm.
	Larkana	65	Ditto		Rice, *juar* and wheat breeding farm.
	Jacobabad	300	Ditto		Wheat farm.
	Sakrand	..	Officer-in-Charge	Director of Agriculture	Headquarters research station for Sind.
	Ganeshkhind, Kirkee	80	Superintendent	Horticulturist to Government, Bombay, Poona.	Botanical garden.
	Modibag, Poona	14	Ditto		Teaching and research fruit farm.
	Poona	275	Ditto	Professor of Agriculture, Poona.	Agricultural College farm.
	Kirkee	868	Manager		Agricultural College dairy.
	Chinsura	210	Farm Superintendent	Deputy Director of Agriculture, Western Circle.	
	Burdwan	35	District Agricultural Officer		
	Berhampore	44	Ditto		
	Bankura	29	Ditto		
	Suri	33	Ditto		
	Krishnagar	34	Ditto		
	Jessore	5	Ditto		
	Sosaba	8	Agricultural Officer		

Bengal	Dacca	354	Chief Farm Superintendent		Central Farm.
	Mymensingh	20	District Agricultural Officer		
	Faridpur	20	Ditto		
	Comilla	20	Ditto	Deputy Director of Agriculture, Eastern Circle.	
	Barisal	20	Ditto		
	Kishoregunj	83	Ditto		
	Jamalpur	35	Ditto		
	Rangamati	11	Ditto		
	Charbadna	67	Ditto		
	Dhanbari	7	Ditto		
	Rajshahi	63	Superintendent	Deputy Director of Agriculture, Northern Circle.	Demonstration farm.
	Rangpur	19	District Agricultural Officer		
	Bogra (old)	22	Ditto		
	Bogra (new)	6	Ditto		
	Pabna	18	Ditto		
	Dinajpur	24	Ditto		
	Mainaguri	25	Ditto		
	Malda	15	Ditto		
	Rangpur	333	Superintendent	Livestock Expert	Cattle farm.
	Rangpur	52	Ditto	Agricultural Chemist	Tobacco farm.
	Kalimpong	70	Manager	Director of Agriculture	
	Kalimpong	..	Superintendent of Sericulture.	Deputy Director of Sericulture	Sericultural research stations.
	Kurseong	..			
	Berhampore	..			
United Provinces	Shahjahanpur	103	Deputy Director	Deputy Director of Agriculture, Rohilkhand Circle.	
	Budaun	19	Overseer		
	Nawabganj (Bareilly)	110	Ditto		
	Nagina (Bijnor)	77	Superintendent		

List of Agricultural Stations in 1928-29—contd.

Province	Agricultural Stations	Area in Acres	Officer in immediate charge	Supervising Officer	Remarks
United Provinces —*contd.*	Cawnpore	72	Superintendent	Deputy Director of Agriculture, Central Circle.	
	Kalianpur (Cawnpore)	258	Ditto		
	Mainpuri	53	Ditto		
	Etawah	61	Ditto		
	Hardoi	55	Ditto		
	Atarra (Banda)	171	Ditto	Deputy Director of Agriculture, Bundelkhand Circle.	
	Jaitpur (Hamirpur)	30	Overseer		
	Partabgarh	90	Superintendent	Deputy Director of Agriculture, Eastern Circle.	
	Naugawan (Sultanpur)	360	Ditto		
	Fyzabad	206	Ditto		
	Benares	78	Ditto		
	Aligarh	88	Ditto	Deputy Director of Agriculture, Western Circle.	
	Kalai (Aligarh)	142	Ditto		
	Muzaffarnagar	100	Ditto		
	Bichpuri (Agra)	100	Ditto		
	Jachonda (Muttra)	86	Inspector		
	Bulandshahr	25	Ditto		
	Meerut	76	Ditto		
	Gorakhpur	110	Overseer	Deputy Director of Agriculture, North-Eastern Circle.	
	Bahraich	102	Ditto		
	Jeolikote (Naini Tal)	51	Ditto	Deputy Director of Agriculture, Hill Circle.	
	Muttra	..	....	Deputy Director of Agriculture, I/C. Cattle Breeding Operations.	Cattle breeding farms.
	Manjha	..	....		

Punjab	Lyallpur Agricultural Farm	430	Manager	Professor of Agriculture, Punjab, Lyallpur.	
	Lyallpur Students' Farm	78			
	Lyallpur Botanical Farm and Fruit Garden.	115	Associate Professor of Botany, Cerealist, Fodder Specialist, Millet Botanist and Fruit Specialist.	Associate Professor of Botany, Lyallpur.	
	Risalewala	858	Manager	Professor of Agriculture, Lyallpur.	Mainly a seed farm.
	Cotton Research Botanist's Farm, Risalewala.	200	Assistant Cotton Research Botanist.	Cotton Research Botanist, Lyallpur.	Cotton experiments.
	Cotton Research Botanist's Farm, Lyallpur.	18	Ditto	Ditto	Ditto.
	Jhang	200	Manager	Deputy Director of Agriculture, Lyallpur.	Seed and demonstration farm.
	Fatna	500	Agricultural Assistant	Deputy Director of Agriculture, Montgomery.	Seed farm.
	Montgomery	549	Manager		Experimental farm.
	Shergarh	1,626	Ditto		Seed farm.
	Harappa Road	558	Agricultural Assistant		For reclamation of saline soils.
	Gurdaspur	263	Ditto	Deputy Director of Agriculture, Gurdaspur.	Experimental farm.
	Beas	43	Ditto		Demonstration farm.
	Gujranwalla	100	Ditto		District farm.
	Kala Shah Kaku	146	Ditto		Rice breeding station.
	Sargodha	657	Manager	Deputy Director of Agriculture, Rawalpindi.	Experimental station and seed farm.
	Chillianwala	250	Ditto		Seed farm.
	Gujrat	50	Agricultural Assistant		District farm.
	Campbellpur	100	Ditto		Ditto.
	Rawalpindi	252	Manager		Experimental station.
	Hansi	589	Ditto	Deputy Director of Agriculture, Hansi.	Ditto.
	Sirsa	419	Ditto		Ditto.
	Firozepore	100	Ditto		District farm.
	Gurgaon	100	Ditto		Ditto.
	Rohtak	100	Ditto		Ditto.
	Ambala	99	Ditto		Ditto.
	Karnal	100	Ditto		Ditto.

List of Agricultural Stations in 1928-29—contd.

Province	Agricultural Stations	Area in Acres	Officer in immediate charge.	Supervising Officer	Remarks
Punjab —*contd.*	Multan	529	Agricultural Assistant	Deputy Director of Agriculture, Multan.	Experimental station.
	Vihari	499	Ditto		Seed farm.
	Mianwali	207	Ditto		District farm.
	Dera Ghazi Khan	139	Ditto		Ditto.
	Ludhiana	54	Ditto	Deputy Director of Agriculture, Jullundur.	Ditto.
	Kangra	10	Ditto		Ditto.
	Jullundur	112	Ditto		Experimental station.
Burma	Mandalay	630	Senior Agricultural Assistant.	Professor of Agriculture, Mandalay Agricultural College.	Central farm.
	Tatkon	106	Ditto	Deputy Director of Agriculture, East Central Circle.	Experimental farm.
	Pyinmana	55	Ditto		Central farm.
	Pyu	146	Ditto		Seed farm.
	Mahlaing	254	Ditto	Deputy Director of Agriculture, Myingyan Circle.	Central farm.
	Kyehmon	307	Ditto		Seed farm.
	Magwe	205	Ditto	Deputy Director of Agriculture, West Central Circle.	Ditto.
	Allanmyo	144	Ditto		Central farm.
	Pwinbyu	137	Ditto		Experimental and seed farm.
	Sa-aing	11	Ditto		Tobacco farm.
	Hnawbi	456	Ditto	Deputy Director of Agriculture, Southern Circle.	Central farm,
	Pegu	180	Ditto		Seed farm
	Paungde	126	Ditto		Ditto.
	Akyab	138	Ditto	Deputy Director of Agriculture, Arakan Circle.	Central farm.
	Kyaukpyu	23	Ditto		Experimental farm.
	Myaungmya	92	Ditto	Deputy Director of Agriculture, Irrawaddy.	Central farm.
	Henzada	148	Ditto		Seed farm.

	Maubin	155	Ditto	Deputy Director of Agriculture, Irrawaddy Circle.	Ditto.
	Taypon	212	Ditto		Ditto.
	Bassein	151	Ditto		Ditto.
	Kanbalu	534	Ditto		Central farm.
	Padu	105	Junior Agricultural Assistant.		Experimental farm.
	Chiba	84	Senior Agricultural Assistant.	Deputy Director of Agriculture, Northern Circle.	Seed farm.
	Singaing	102	Ditto		Ditto.
	Mudon	88	Ditto	Deputy Director of Agriculture, Tenasserim Circle.	Central farm.
	Thaton	151	Ditto		Seed farm.
	Paukkaung	16	Ditto	Entomologist	Experimental farm for mulberry plantation.
	Cuttack	150	Manager	Assistant Director of Agriculture, in charge of Orissa Range, Cuttack.	
	Khurda	81	Inspector		
	Balasore	75	Overseer		
	Angul	47	Ditto		
	Puri	42	Ditto		
	Anantapur	30	Ditto		
Bihar and Orissa	Sepaya	379	Manager	Deputy Director of Agriculture, North Bihar Range, Sepaya.	
	Siwan	25	Overseer		
	Darbhanga	26	Ditto		
	Purnea	60	Assistant Director of Agriculture.		
	Sabour	190	Ditto	....	
	Jamui	38	Inspector	Assistant Director of Agriculture, in charge of South-East Bihar Range, Monghyr.	
	Banka	26	Ditto		
	Monghyr	200	Manager		Dairy farm.
	Gaya	193	Ditto	Deputy Director of Agriculture, South Bihar Range, Ga	
	Nawadah	83	Overseer		
	Bikramganj	24	Ditto		
	Siris	35	Ditto		

List of Agricultural Stations in 1928-29—contd.

Province	Agricultural Stations	Area in Acres	Officer in immediate charge	Supervising Officer	Remarks
Bihar and Orissa *contd.*	Kanke	340	Manager	Deputy Director of Agriculture, Chota Nagpur Range, Kanke.	
	Netarhat	193	Overseer		
	Purulia	52	Inspector		
	Ramgarh	43	Overseer		
	Chianki	32	Ditto		
	Sambalpur	32	Inspector		
	Chaibasa	38	Ditto		
Central Provinces	Nagpur	268	Superintendent	Principal, Agricultural College, Nagpur.	College farm.
	Akola	271	Ditto	Economic Botanist, Nagpur.	
	Borgaon	868	Ditto	Deputy Director of Agriculture, Western Circle, Amraoti.	
	Yeotmal	106	Ditto		
	Khandwa	177	Ditto		
	Basim	109	Ditto		
	Buldana	134	Ditto		
	Sindewahi	197	Ditto	Deputy Director of Agriculture, Southern Circle, Nagpur.	
	Tharsa	116	Ditto		
	Wara-Seoni	63	Ditto		
	Telinkheri	1,000	Ditto	Deputy Director of Agriculture, in charge Animal Husbandry, Nagpur.	Dairy farm.
	Raigarh (Garhi)	1,200	Ditto		Cattle breeding farm.
	Ellichpur	300	Ditto		Ditto.
	Bod	2,900	Ditto		Ditto.
	Pendra	2,200	Ditto		Ditto.

	Chandkhuri	333	Ditto	Deputy Director of Agriculture, Eastern Circle, Raipur.	
	Bilaspur	253	Ditto		
	Drug	281	Ditto		
	Raipur	229	Ditto		
	Seoni	164	Ditto	Deputy Director of Agriculture, Northern Circle, Jubbulpur.	
	Chhindwara	69	Ditto		
	Betul	161	Ditto		
	Narsinghpur	..	Ditto		
	Powarkhera (Hoshangabad).	528	Ditto		
	Adhartal (Jubbulpore)	637	Ditto		
	Saugor	161	Ditto		
	Damoh	152	Ditto		
Assam	Jorhat	59	Manager	Deputy Director of Agriculture, Assam.	Sugarcane station.
	Titabor	120	Ditto		Rice station.
	Upper Shillong	367	Ditto		Potato station.
	Karimganj	80	Ditto		Rice station.
	Khanapara	200	Ditto		Cattle breeding farm.
North-West Frontier Province	Tarnab (Peshawar)	200	Ditto	Agricultural Officer, North-West Frontier Province, Tarnab.	
	Haripur (Hazara)	16	Ditto		

(*b*) Indian States.

Hyderabad	Himayat Sagar	298	Main Farm Superintendent	Deputy Director of Agriculture, Telangana.	Main farm.
	Sangareddy	101	Farm Superintendent		
	Alir	63	Ditto		
	Mahboobnagar	160	Ditto		
	Nizam Sagar	6	Ditto		
	Parbhani	280	Main Farm Superintendent	Deputy Director of Agriculture, Maratwara.	Main Farm.

List of Agricultural Stations in 1928-29—concld.

Provin	Agricultural Stations	Area in Acres	Officer in immediate charge	Supervising Officer	Remarks
Mysore	Hebbal	80	Vice Principal, Agricultural School.	Director of Agriculture	Experimental farm.
	Nagenahalli	60	Junior Assistant Botanist	Economic Botanist.	Paddy Breeding Station.
	Hunsur	42	Ditto	Economic Botanist.	Kar Ragi Breeding Station.
	Yellachihalli	..	Livestock Officer	Director of Agriculture.	Sheep Breeding Station.
	Babbur	200	Farm Manager	Director of Agriculture.	Experimental Station.
	Balehonnur	..	Mycologist	Director of Agriculture.	Coffee Experimental Station.
	Parvatharayanakere	..	Manager	Director of Agriculture.	Cattle Breeding Station.
	Marthur	56	Agricultural Inspector	Deputy Director of Agriculture, Shimoga.	Areca, pepper and paddy farm.
Baroda	Baroda	89	Farm Superintendent	Director of Agriculture.	
	Jagudan	15	Farm Superintendent and Agricultural Inspector.	Director of Agriculture.	
	Amreli	89	Ditto	Director of Agriculture.	
Travancore	Cape Comorin	16	Agricultural Inspector	Director of Agriculture and his Assistant.	Fruit farm.
	Nagercoil	40	Ditto	Director of Agriculture and his Assistant.	Paddy farm.
	Esanthimangalam	7	Veterinary Inspector	Director of Agriculture and Agricultural Inspector, Trivandrum.	Cattle breeding farm.
	Eranie	17	Agricultural Inspector	Director of Agriculture and Agricultural Inspector, Nagercoil.	Demonstration farm.
	Trivandrum	100	Ditto	Director of Agriculture and his Assistant.	Cattle farm.
	Kottarakara	100	Agricultural Sub-Inspector	Director of Agriculture and Agricultural Circle Inspector, Kottarakara.	Demonstration farm.
	Puliyara	40	Ditto	Director of Agriculture and Agricultural Circle Inspector, Kottarakara.	Ditto.
	Koni	150	Agricultural Inspector	Director of Agriculture and Agricultural Circle Inspector, Kottarakara.	Pepper farm.

	Onchora	4	Agricultural Demonstrator.	Director of Agriculture and Agricultural Inspector, Mavelikarai.	Coconut demonstration farm.
	Alleppey	8	Ditto	Director of Agriculture and Agricultural Inspector, Sherthalai.	Coconut experimental farm.
	Ponkand	25	Agricultural Sub-Inspector		Kari experimental station.
	Alwaye	18	Head Master, Agricultural School.	Director of Agriculture and his Assistant.	Agricultural School farm.
	Valkom	6	Agricultural Inspector, Sherthalai.		Coconut demonstration farm.
Bhopal	Nabi Bagh	170	Assistant Director of Agriculture.	Director of Agriculture	Principal experimental farm.
	Nazhat Afza	41	Ditto		Sugar research station.
	Nishat Afza	5	Ditto		Sugarcane farm.
	Int-kheri	70	Ditto		
Patiala	Bhupindra Agricultural Farm, Patiala.	100	....	Ditto	

APPENDIX III

Staff of the Provincial Departments of Agriculture in India during 1928-29.

(a) British India.

Province	RESEARCH AND TEACHING STAFF.						DISTRICT STAFF.					
	SUPERIOR SERVICE (IN AND OUTSIDE I. A. S.)		PROVINCIAL SERVICE		SUBORDINATE SERVICE		SUPERIOR SERVICE (IN AND OUTSIDE I. A. S.)		PROVINCIAL SERVICE		SUBORDINATE SERVICE	
	Sanctioned cadre	Filled substantively	Sanctioned cadre	Filled substantively	Sanctioned cadre	Filled substantively	Sanctioned cadre	Filled substantively	Sanctioned cadre	Filled substantively	Sanctioned cadre	Filled substantively
Madras	13	11	17	17	124	113	12	9	20	20	254	244
Bombay	6	6	15	15	28	28	8	8	9	9	275	275
Bengal	6	6	4	3	35	35	3	1	5	4	159	147
United Provinces	8	5	10 (c)	10	38	38	12	5	19	19	138	138
							4*	4*	0*	0*	158*	158*
Punjab	22 (a)	16 (b)	15 (c)	15 (c)	58	58	10 (d)	9 (c)	23 (c)	23 (c)	475	468
Burma	4	3	11	6	18	12	11	8	23	7	84	55
Bihar and Orissa	2	..	4	4	2	2	8	4	11	11	96	89
Central Provinces	5	4	6	6 (e)	22	21	9	5	10	10	117	117
Assam	1	1	..	..	5	5	2	2	3	3	80	80
North-West Frontier Province	1	1	..	..	6	5	..	..	..	..	..	..

(a) Includes 14 temporary posts. (b) Includes 12 temporary posts. (c) Includes 1 temporary post. (d) Includes 2 temporary posts.
(e) Includes 1 post attached to the office of Director of Agriculture. * Outside ordinary cadres.

(b) Indian States.

Hyderabad	1	1	1	1	3	2	3	3	5	4	32	26
Mysore	14	14	..	..	26	26	6	6	..	..	102	102
Baroda	..	..	..	..	..	..	1	1	9	9	21	21
Travancore	5	5	..	..	2	2	2	2	..	..	32	32
Patiala	..	..	..	..	7	7	..	..	1	1	2	1

APPENDIX IV.

Showing results of well-boring during 1928-29.

Province	1928-29		1927-28	
	Number of bores	Number successful	Number of bores	Number successful
(a) British India.				
Madras	746	478	843	572
Bombay	254	149	312	181
Bengal	130	122	80	80
United Provinces	1,552	1,227	939	699
Punjab	966	774	725	608
Bihar and Orissa	303	287	366	290
Central Provinces	..	..	1	..
(b) Indian States.				
Assam	1	..	..	..
Hyderabad	58	52	56	44
Baroda	32	18	49	32
Patiala	22	20	11	8

APPENDIX V.

Showing sale of improved implements through departmental agency during 1928-29.

Province	Ploughs		Cane Mills		Fodder Cutters		Hoes		Other Implements		Spare parts	
	1928-29	1927-28	1928-29	1927-28	1928-29	1927-28	1928-29	1927-28	1928-29	1927-28	1928-29	1927-28
(a) British India.												
Madras	2,045	2,424	25	31	29	56	19	30	541	341	3,907	3,426
Bombay	397	768	15	35	6	13	20	56	715	256	204	464
Bengal	47	10	..	2	..	..	13	9	4	11	9	3
United Provinces	5,049	3,787	130	119	58	47	40	64	190	141	8,242	7,203
Punjab	7,510	8,840	915	278	7,142	3,310	125	369	2,435	3,848	4,891	2,407
Burma	4,483	2,950	15	2	2	5	5	23	146	144	907	1,712
Bihar and Orissa	324	42	24	6	6	2	..	..	16	54	2	5
Central Provinces	7,613	5,780	162	152	98	48	99	210	877	749	11,494	9,002
Assam	5	1	108	150	..	..	..	..	50	45	60	16
North-West Frontier Province	5	2	..	..	..	..	..	..	2	..	12	2
(b) Indian States.												
Mysore	1,401	1,586	19	116	..	1	69	187	23	..	3,685	5,52 8
Baroda	66	32	..	..	..	..	..	..	..	..	..	..
Travancore	765	465	..	..	..	..	..	..	..	..	..	..
Bhopal	2	..	..	..	..	..	..	..	..	..	..	..

APPENDIX VI.

Improved seeds and manures distributed through departmental agency during 1928-29.

Province.	SEED DISTRIBUTED						MANURES DISTRIBUTED			
	SEED GRAIN IN CWT.		NO. OF WHOLE CANES EXCEPT WHERE OTHERWISE STATED		FRUIT PLANTS (No.)		COMMERCIAL FERTILIZERS IN CWT.		OIL CAKES IN CWT.	
	1928-29	1927-28	1928-29	1927-28	1928-29	1927-28	1928-29	1927-28	1928-29	1927-28
(a) British India.										
Madras	17,071	10,932	72,515	14,504	100,449	21,821	161,195	54,286	34,949	8,024
Bombay	25,324	29,357	12,550 setts 64,090	93,790	24,629	52,469	4,891	3,332	129	309
Bengal	4,688	3,116	2,237,268	1,731,333	157	170	653	1,241	89	138
United Provinces	92,065	55,057	291,523 cwt.	96,242 cwt.	15,369	15,829	2,281	2,388	11,525	6,933
Punjab	62,509	51,073	*	*	*	*	*	*	*	*
Burma	62,660	61,860	82,410	21,825	817	282	96	208	..	..
Bihar and Orissa	1,435	1,770	28,519 cwt.	19,110 cwt.	1,209	912	5,220	8,700	..	..
Central Provinces	322,472	179,300	808,273	818,102	5,906	5,069	1,636	659	472	514
Assam	589	3,104	53,012	157,688	4,098	4,102	4,503	1,454	101	91
North-West Frontier Province	223	215	25 cwt.	23 cwt.	17,500	13,000	..	..	..	..
(b) Indian States.										
Mysore	683	584	1,25,813	30,635	..	..	798	7,712	340	1,965
Baroda	3,199	460	..	..	..	..	..	..	..	..
Travancore	313	389	..	..	..	..	867	..	..	..
Bhopal	130	..	128,300	230,200	..	..	100	14	..	..
Patiala	193	107	..	570 cwt.	..	..	..	..	..	..

* Not available.

APPENDIX VII.

Demonstration and propaganda work during 1928-29.

Province	Number of agricultural shows held		Number of practical demonstrations carried out		Number of illustrated lectures given	
	1928-29	1927-28	1928-29	1927-28	1928-29	1927-28
(a) British India.						
Madras	252	125	7,060	5,430	305	241
Bombay	38	36	1,167	1,282	176	130
Bengal	35	23	2,613	1,934	130	85
United Provinces	89	82	26,458	18,377	642	92
Burma	32	20	842	1,241	102	114
Bihar and Orissa	7	2	3,603	2,964	1	..
Central Provinces	38	47	4,040	4,339	160	231
Assam	6	5	1,703	1,020	25	..
North-West Frontier Province	..	..	..	3	..	..
(b) Indian States.						
Mysore	4	3	814	500	..	..
Baroda	..	2	..	1	..	..
Travancore	4	4	350	350	350	200
Bhopal	..	..	10	6	..	..
Patiala	17	18	31	26	72	81

NOTE.—Figures for the Punjab are not available.

APPENDIX VIII.

Agricultural Colleges and Schools in British India during 1928-29.

Name of College or School	Courses of instruction	1928-29				1927-28				Remarks
		Applications for admission	Admissions made during the year	Total number on the roll	Number passed in final examination	Applications for admission	Admissions made during the year	Total number on the roll	Number passed in final examinations	
(a) Post-graduate Training Institutions.										
Agricultural Research Institute, Pusa.	Two-year Post-graduate Course.	26	6	11	2	35	4	11	5	
Imperial Institute of Animal Husbandry and Dairying, Bangalore.	(1) (*a*) Fifteen-month Post-graduate Course.	..	3	7	4	..	4	9	5	
	(*b*) Twenty-four-month Course.	..	..	1	..	..	..	..	..	
	(2) Two-year Indian Dairy Diploma Course.	..	4	31	3	48	27	49	18	
	(3) Short Courses in Animal Husbandry and Dairying for varying periods.	21	21	21	16	16	16	16	16	
Imperial Cane Breeding Station, Coimbatore.	Courses in methods of sugarcane breeding for varying periods from one year to three months.	5	5	5	..	..	..	..	..	
(b) Provincial Agricultural Colleges.										
Agricultural College, Coimbatore.	Three-year B. Sc. Ag. Degree Course.	307	41	121	19	176	41	106	18	Affiliated to the University of Madras.
Agricultural College, Poona	(1) Three-year B. Ag. Degree Course.	187	75	216	60	168	72	199	38	Affiliated to the University of Bombay.
	(2) College Diploma Course.	..	..	..	4	..	..	..	3	

Agricultural Colleges and Schools in British India during 1928-29—contd.

Name of College or School	Courses of instruction	1928-29				1927-28				Remarks
		Applications for admission	Admissions made during the year	Total number on the roll	Number passed in final examination	Applications for admission	Admissions made during the year	Total number on the roll	Number passed in final examination	
(*b*) Provincial Agricultural Colleges.										
Agricultural College, Cawnpore.	(1) Four-year L. Ag. Diploma Course.	182	50	131	8	152	44	111	9	
	(2) Two-year Certificate Course.	113	30	46	13	105	31	44	13	
Punjab Agricultural College, Lyallpur.	(1) Four-year B. Sc. Ag. Degree Course.	(*a*) 412	44	233	28	(*a*) 450	68	233	16	Affiliated to the University of Punjab.
	(2) One-and-a-half-year M. Sc. Degree Course.	7	4	6	1	4	2	4	..	
	(3) Two-year Certificate Course.	..	..	18	15	..	..	23	21	Not affiliated to the University of Punjab.
	(4) Six-month Vernacular Course (Summer Class).	231	38	38	37	66	20	20	17	(*a*) Total number of applications received for admission to Leaving Certificate and Degree Course.
	(5) Six-month Vernacular Course (Winter Class).	171	41	41	39	125	40	39	..	
	(6) One-month Rural Economy Course.	21	21	21	21	154	41	41	40	
	(7) Ten-and-a-half-month Teachers' Training Course.	59	35	31	28	30	30	30	30	
	(8) Six-week Blacksmith Class.	39	17	17	17	42	32	30	30	
Agricultural College, Mandalay.	Three-year Diploma Course.	60	22	43	10	60	24	50	9	
Agricultural College, Nagpur.	(1) Four-year Degree Course.	91	51	40	5	94	46	88	..	Affiliated to the Nagpur University.
	(2) Four-year College Diploma Course.				3	..	..	12	..	
	(3) Two-year Certificate Course.	17	9	7	5	18	7	16	5	

(c) Agricultural Schools.

Madras.									
Agricultural Middle School, Taliparamba.	Two-year Course . .	40	19	44	17	79	38	41	8
Bombay.									
Vernacular Agricultural School, Loni Kalbhor (in Marathi).	Ditto . .	93	18	39	15	159	25	45	22
Vernacular Agricultural School, Devihosur (in Kanarese).	Ditto . .	68	12	27	13	75	17	30	9
Vernacular Agricultural School, Jambul (in Marathi).	Ditto . .	10	8	20	8	13	13	24	10
Vernacular Agricultural School, Godhra (in Gujarati).	Ditto . .	47	18	18	16	34	16	30	26
Vernacular Agricultural School, Dhulia (in Marathi).	Ditto . .	49	17	31	13	80	17	30	11
Vernacular Agricultural School, Surat (in Gujarati).	Ditto . .	37	15	31	31	45	13	22	16
Bengal.									
Secondary Agricultural School, Dacca.	Two-year Course for regular students and one-year Course for Demonstrators.	27	26	29	8	45	39	58	4
United Provinces.									
Vernacular Agricultural School, Bulandshahr.	(1) Two-year Vernacular Course.	90	36	33	28	72	36	67	30
	(2) Teachers' Training Class.	12	12	12	13	13	13	13	11
	(3) Fieldmen's Course .	..	..	..	..	14	10	8	4
	(4) Engine Drivers' Course.	10	10	10	5	13	10	10	3
	(5) Garden Overseers' Course.	12	10	10	..	..	..	..	..

AgriculturalColleges and Schools in British India during 1928-29—contd.

Name of College or School	Courses of instruction	1928-29				1927-28				REMARKS
		Applications for admission	Admissions made during the year	Total number on the roll	Number passed in final examination	Applications for admission	Admissions made during the year	Total number on the roll	Number passed in final examination	
(c) Agricultural Schools—*contd.*										
Punjab.										
Agricultural Vernacular Class, Gurdaspur.	(1) Six-month Vernacular Course (Summer Class).	75	30	30	30	125	58	48	46	
	(2) Six-month Vernacular Course (Winter Class.	100	32	32	32	210	54	52	48	
Agricultural Vernacular Class, Hansi.	(1) Six- month Vernacular Course (Summer Class)	79	35	21	15	49	31	25	22	
	(2) six-month Vernacular Course (Winter Class)	50	38	23	10	50	42	22	..	
Burma.										
Agricultural School, Pyinmana.	Four-year course	..	54	65	9	..	60	60	8	The school is run by the American Baptist Mission and subsidized by Government.
Central Farm School, Hmawbi.	(1) Short-course of practical training for 9 months.	..	10	10	6	..	10	8	5	
	(2) Short-courses of practical instruction.	..	35	35	35	..	35	35	..	
Central Farm School, Mahlaing.	(1) Short-course of practical training for 9 months.	..	12	7	7	..	10	10	9	
	(2) Short-courses of practical instruction.	..	21	21	21	..	23	23	..	

Central Farm School, Tatkon	Short-courses of practical instruction.	..	14	12	12	..	2	2	..	
Central Farm School, Padu .	Ditto .	..	12	12	12	..	2	2	..	
Central Farm School, Allamyo.	Ditto .	..	50	50	50	..	19	19	..	
Central Provinces.										
Agricultural Middle School, Powarkhera.	Four-year Course . .	52	35	32	10	52	32	69	10	
Mysore State.										
Agricultural School, Hebbal	Three-year course in English leading to an L. Ag. Diploma.	68	26	44	10	57	17	36	16	
Vernacular Agricultural School, Chikkanahalli.	One-year Course . .	..	19	19	19	..	18	18	15	
Vernacular Agricultural School, Hassan.	Ditto . .	12	12	12	..*	..	..	..	..	Opened in January 1920.
Vernacular Agricultural School, Ramakrishnapur.	Ditto . .	..	15	15	..*	..	..	..	..	Opened in May 1929.
Baroda State.										
Agricultural School, Baroda Farm.	(*a*) Agriculture, Horticulture, Animal Husbandry, etc.	33	15	13	11	32	20	18	16	
	(*b*) Class for tractor and Oil-Engine.	21	18	18	18	34	13	13	13	
Travancore State.										
Agricultural School, Kottarakara.	Two-year Course . .	125	32	27	..*	..	..	..	..	Opened in 1928.
Agricultural School, Alwaye	Ditto . .	50	18	16	..*	25	18	16	12	
Patiala State.										
Bhupindra Agricultural Institute, Patiala.	Ditto . .	19	10	11	..*	22	20	19	19	

* Examination has not yet been held.

APPENDIX IX.

Operations of Non-Credit Agricultural Co-operative Societies in British India during 1928-29.

The two tables below include Agricultural Societies for—

A. 1. *Purchase and Purchase and Sale.* These are societies intended to facilitate the purchase of agricultural requisites for members, such as societies which purchase seed, manure, implements, etc., for sale to their members. Societies of this character which collect for joint sale the produce of members without making this their main object are also included in this class.

2. *Production.* These are societies which have for their chief object an act of production without proposing to themselves sale as a direct object. These also include societies for joint irrigation, for collective use of machinery, for assistance in horse and cattle breeding, etc.

3. *Production and sale.* This class includes societies in which these two functions are united or in which one or the other predominates, it being impossible to make a clear distinction between them. It covers all societies whose main object is the joint sale of any commodity, whether such commodity is produced or worked up or prepared for sale by the society itself or by the members individually. It comprises all co-operative creameries and distilleries, as well as societies whose main object is the sale of grain, cattle, eggs, *ghi*, etc., produced by their members.

4. Other forms of co-operation except insurance.

B. Insurance.

Operations of Non-Credit Agricultural Co-operative Societies in British India during 1928-29.

(A) PURCHASE, SALE AND PRODUCTION.

Province	Class of societies	Number of societies	Number of members	Sale of goods to members	Purchase of members' products	Working capital	Profit and loss for the year	REMARKS
				(a) British India.				
				Rs.	Rs.	Rs.	Rs.	
Madras . .	Purchase, and purchase and sale.	133	11,097	..	..	5,64,438	—3,238	
	Production and sale .	41	1,293	..	..	1,82,943	—21,548	
	Others . . .	387	22,569	..	..	4,25,154	—4,546	
	TOTAL .	561	34,959	..	..	11,72,535	—29,332	
Bombay . .	Purchase, and purchase and sale.	54	3,134	33,962	16,771	1,68,546	+20,588	
	Production . . .	16	514	..	..	11,435	—1,127	
	Production and sale .	80	15,188	4,12,779	6,97,926	13,98,641	+48,692	
	Others . . .	101	57,007	55,638	4,413	3,37,052	+2,48,940	
	TOTAL .	251	75,843	5,02,379	7,19,110	19,15,674	+3,17,093	
Bengal . .	Purchase, and purchase and sale.	100	28,982	82,20,361	87,18,138	37,15,741	—1,84,579	
	Production . . .	773	20,133	..	..	3,83,063	—12,048	
	Production and sale .	172	10,737	2,71,675	7,04,184	7,19,754	+1,76,718	
	Others . . .	34	9,235	2,664	874	77,615	+2,187	
	TOTAL .	1,079	69,087	84,94,700	94,23,196	48,96,173	—17,722	

Operations of Non-Credit Agricultural Co-operative Societies in British India during 1928-29—contd.

(A) PURCHASE, SALE AND PRODUCTION—*contd.*

Province	Class of societies	Number of societies	Number of members	Sale of goods to members	Purchase of members' products	Working capital	Profit and loss for the year	REMARKS
				(a) British India—*contd.*				
				Rs.	Rs.	Rs.	Rs.	
United Provinces	Production and sale	13*	9	..	4,147	4,110	—226	* 12 societies did not start work.
	Others	41	1,073	..	..	469	+347	
	TOTAL	54	1,082	..	4,147	4,579	+121	
Punjab	Purchase, and purchase and sale.	15	1,097	97,476	98,374	46,945	+6,110	
	Production	201	4,974	..	..	6,827	+583	
	Production and sale	695	33,064	28,35,876	53,49,211	7,40,973	+21,296	
	Others	82	1,480	..	..	63,708	+4,169	
	TOTAL	993	40,615	29,33,352	54,47,585	8,58,453	+32,158	
Burma	Purchase, and purchase and sale.	15	1,063	14,759	9,396	43,175	+400	
	Production	5	50	..	..	..	..	
	Production and sale	25	2,004	5,216	..	1,77,311	—31,899	
	TOTAL	45	3,117	19,975	9,396	2,20,486	—31,499	
	Purchase, and purchase and sale.	4	275	1,748	1,652	8,098	+284	
	Production	3	140	..	..	6,062	..	

Bihar and Orissa	Production and sale	9	163	203	1,510	15,131	—4,516	†And 61,782 maunds of grain.
	Others	2	21	..	..	758	—192	‡And profit of 13,682 maunds of grain.
	Grain golas	83	27,249	..	..	2,30,956†	+15,503‡	
	TOTAL	101	27,848	1,951	3,162	2,61,005	+11,079	
Central Provinces	Purchase, Purchase and sale.	21	1,238	1,07,813	..	98,650	+13,463	
	Production	4	43	290	..	1,318	+30	
	Production and sale	5	584	15,239	349	40,310	+4,210	
	TOTAL	30	1,865	1,23,342	349	1,40,278	+17,703	
Assam	Production and sale	2	131	..	17,120	10,525	—3,656	
	TOTAL	2	131	..	17,120	10,525	—3,656	

(b) Indian States.

Mysore	Purchase, Purchase and sale.	49	1,148	99,852	66,550	77,807	+3,667
	Production	1	11	..	..	3,738	..
	Production and sale	20	367	297	..	13,766	+897
	TOTAL	70	1,526	1,00,149	66,550	95,311	+4,564
Baroda	Purchase and sale	13	421	4,895	..	2,302	+242
	Production	30	844	..	..	36,761	+577
	Production and sale	23	805	5,592	5,863	14,400	+69
	TOTAL	66	2,070	10,487	5,863	53,406	+888

Operations of Non-Credit Agricultural Co-operative Societies in British India during 1928-29—contd.

(B) CATTLE INSURANCE.

Province	Number of societies	Amount of risk insured	Premia collected during the year	Supplementary contributions collected	Number of animals		Claims paid	Cost of management	Funds in hand at the end of year	Amount of risk re-insured	Amount or premia paid for re-insurance
					Insured	Lost					
		Rs.	Rs.				Rs.	Rs.	Rs.	Rs.	Rs.
Bombay . .	6	5,020	251	..	88	2	53	92	1,316	..	..
Madras . .	4	..	..	..	2	..	..	1	50	152	3
Burma . .	376	5,005	344	..	81	5	326	61	36,623	2,027	142
	1*	14,480	235	..	263	10	175	1,051	15,540	..	..

* Central Reinsurance Society.

APPENDIX X.

Showing the working of the Provincial Veterinary Departments during 1928-29.

Province	Reported mortality from contagious diseases			Dispensaries and Hospitals			District work					
	Rinderpest	Other diseases	Total	Number of institutions	Cases treated	Castrations performed	Cases treated	Castrations performed	Outbreaks in which inoculation was undertaken	Deaths uninoculated	Inoculations	Deaths after inoculation
Madras	129,583	41,415	170,998	107	144,899	5,139	49,147	4,341	1,949	40,446	270,876	1,089
Bombay	4,831	11,004	15,835	106	212,119	17,650	77,133	14,346	744	5,870	78,314	96
Bengal	8,806	5,042	13,848	44	69,959	107	131,527	37	612	9,454	124,076	526
United Provinces	13,479	12,614	26,093	160	270,003	3,150	60,971	240	1,164	11,091	150,569	103
Punjab	14,737	14,409	29,146	258	952,635	160,465	262,650	170,424	2,025	7,263	520,195	121
Burma	22,061	3,578	25,639	5	14,679	21	128,568	66	746	11,021	106,478	1,361
Bihar and Orissa	16,385	11,509	27,894	*32	67,376	2,669	118,998	27,891	1,661	4,565	328,153	1,027
Central Provinces	17,878	10,812	28,690	100	279,893	6,272	274,489	58,211	1,877	10,923	274,073	286
Assam	4,115	16,363	20,478	8	4,687	156	81,002	4,480	166	2,107	12,799	60
North-West Frontier Province	489	2,559	3,048	†18	73,631	10,162	55,333	23,194	49	720	12,374	9
Sind	4,624	2,200	6,824	18	32,130	846	4,546	731	228	2,679	18,189	68
Baluchistan	200	2,759	3,059	10	19,427	97	22,101	40	12	366	2,901	21
Rajputana	163	101	264	2	3,754	7	266	7	4	162	431	1
TOTAL FOR 1928-29	237,441	134,375	371,816	863	2,145,201	206,041	1,266,731	303,958	11,237	115,757	1,899,428	4,768
TOTAL FOR 1927-28	185,415	125,587	311,222	831	2,106,107	168,109	1,320,729	240,127	9,968	113,027	1,727,055	3,590

* There are also 98 dispensaries, the working of which is shown, under District Work, in columns 8 and 9.
† There are also 34 touring dispensaries, the working of which is shown, under District Work, in columns 8 and 9.

APPENDIX XI.

Showing the details as to Students of Veterinary Colleges and Schools in India during 1928-29.

Veterinary College or School	Course of instruction	Number of Students						Students admitted during the year classed by educational qualifications		
		Admitted during the year		Passed final examination during the year	Failed to pass final examination	Remaining under instruction at end of the year.		Matriculates, school finals or with higher qualifications	Knowing some English but not matriculates	Knowing no English or very little English
		Scholarship holders	Others			In ordinary course	Instruction prolonged by reason of failure to pass			
Madras College. Veterinary	3 years' English Course.	34	6	20	7	47	27	40	..	..
	Post Diploma Course.	9		6	8	..	..	..	..	..
Bombay College. Veterinary	3 years' English Course.	4	40	23	8	89	15	24	20	..
Bengal College. Veterinary	Ditto	37	50	22	23	89	37	60	7	..
Punjab College. Veterinary	4 years' English Course.	47		16	7	91	32	47	..	..
	Refresher Course	1		1	..	..	..	1	..	..
Insein Veterinary School	3 years' Vernacular Course.	....		..	..	13	..	..	..	..

APPENDIX XII.

Showing the number of cattle issued from Government Farms during 1928-29.

Province.	Bulls	Cows	Male buffaloes	She buffaloes	Young stock	Total for 1928-29	Total for 1927-28
Madras	55	61	5	1	34	156	65
Bombay	66	71	..	..	67	204	204
Bengal	18	..	..	..	..	18	14
United Provinces	714	..	65	..	..	779	635
Punjab	326	..	..	..	..	326	436
Bihar and Orissa	5	91	2	..	63	161	158
Central Provinces	24	17	9	..	172	222	523
Assam	18	14	..	..	2	29	22
North-West Frontier Province	3	3	..	..	..	6	5
Imperial Farms.							
Pusa	1	30	..	..	52	83	91
Karnal	2	32	1	4	63	102	42
Bangalore	..	14	..	2	10	26	34
Wellington	..	9	..	..	3	12	39

APPENDIX XIII.

List of Agricultural Publications in India during 1928-29.

No.	Title	Author	Where published
	GENERAL AGRICULTURE.		
1	*The Agricultural Journal of India*, Vol. XXIII, Parts IV, V and VI, and Vol. XXIV, Parts I, II and III. Price, Re. 1-8 or 2*s.* per part. Annual subscription, Rs. 6 or 9*s.* 6*d.*	The Agricultural Adviser to the Government of India (Editor).	Government of India Central Publication Branch, Calcutta.
2	*Seasonal Notes* of the Punjab Department of Agriculture (Half yearly).	Issued by the Department of Agriculture, Punjab.	Government Printing, Lahore.
3	*The Journal of the Mysore Agricultural and Experimental Union* (Quarterly). Annual subscription, Rs. 3.	B. Narasinha Iyengar (Chief Editor).	Bangalore Press, Bangalore.
4	*The Madras Agricultural Journal* (Monthly). Annual subscription, Rs. 4; single copy, As. 6.	B. Viswanath and others (Editors).	The Electric Printing Works, Coimbatore.
5	*Poona Agricultural College Magazine* (Quarterly). Annual subscription, Rs. 2-8; single copy, As. 10.	V. G. Deshpande and S. M. Rao (Editors).	Aryabhushan Press, Poona City.
6	*The Nagpur Agricultural College Magazine* (Quarterly). Annual subscription, Rs. 3.	S. M. Ali and N. B. Chinchalkar (Editors).	Udyam Desha Sevak Press, Nagpur.
7	*The Allahabad Farmer* (Quarterly). Single copy, As. 8 (per year Rs. 2).	W. B. Hayes (Editor) .	The Mission Press, Allahabad.
8	*Quarterly Journal of the Indian Tea Association.* Price, As. 6 per copy.	Scientific Department of the Indian Tea Association, Calcutta.	Catholic Orphan Press, Calcutta.
9	*The Planters' Chronicle* (Weekly). As. 8 per copy.	F. E. James (Editor) .	Diocesan Press, Post Box 455, Madras.
10	*Rural India* (Monthly). Single copy, As. 6. Annual subscription, Rs. 3.	A. Swaminatha Aiyer (Editor).	Magazine Press, Chingleput.
11	Review of Agricultural Operations in India, 1927-28. Price, Rs. 2-6 or 4*s.* 3*d.*	D. Clouston, C.I.E. .	Government of India Central Publication Branch, Calcutta.

List of Agricultural Publications in India during 1928-29—contd.

No.	Title	Author	Where published
	GENERAL AGRICULTURE —*contd.*		
12	Scientific Reports of the Agricultural Research Institute, Pusa (including the Reports of the Imperial Dairy Expert, Physiological Chemist, Government Sugarcane Expert and Secretary, Sugar Bureau) for the year 1927-28. Price, Rs. 2-6 or 4*s.* 3*d.*	Issued by the Agricultural Research Institute, Pusa.	Government of India Central Publication Branch, Calcutta.
13	Annual Report of the Indian Central Cotton Committee, Bombay, 1928. Price, Rs. 2.	J. H. Ritchie .	G. Claridge & Co., Ltd., Bombay.
14	Rice crop in the United Provinces. A Preliminary Note on —. Pusa Agricultural Research Institute Bulletin No. 186. Price, As. 7 or 9*d.*	R. L. Sethi . .	Government of India Central Publication Branch, Calcutta.
15	Farm Buildings. Design for —. Pusa Agricultural Research Institute Bulletin No. 188. Price, As. 6 or 8*d.*	G. S. Henderson . .	Ditto.
16	Agricultural Implements and Machinery at Pusa, Part I: Cultivation Implements and Machinery. Pusa Agricultural Research Institute Bulletin No. 191. Price, As. 12 or 1*s.* 3*d.*	G. S. Henderson and Arjun Singh.	Ditto.
17	Agricultural Implements and Machinery at Pusa, Part II: Harvesting and Threshing Implements and Machinery. Pusa Agricultural Research Institute Bulletin No. 192. Price, As. 6 or 8*d.*	Ditto . .	Ditto.
18	Agricultural Implements and Machinery at Pusa, Part III: Special and Miscellaneous Implements and Machinery. Pusa Agricultural Research Institute Bulletin No. 193. Price, As. 9 or 1*s.*	Ditto .	Ditto.
19	Agricultural Implements and Machinery at Pusa, Part IV: Power Implements and Machinery. Pusa Agricultural Research Institute Bulletin No. 194. Price, As. 12 or 1*s.* 3*d.*	Ditto .	Ditto.

List of Agricultural Publications in India during 1928-29—contd.

No.	Title	Author	Where published
	GENERAL AGRICULTURE —*contd.*		
20	Sugarcane. Report on —. Madras Department of Agriculture Leaflet No. 51.	S. Sundararaman . .	Government Press, Madras.
21	Paddy. Points to note in preparing dry seed beds for —. Madras Department of Agriculture Leaflet No. 52.	N. Sitaramaswami .	Ditto.
22	Training of practical cultivators, maistries or field coolies. Madras Department of Agriculture Leaflet No. 53.	Issued by the Department of Agriculture, Madras.	Ditto.
23	Sugarcane. A Note on Varieties of — in the Vizagapatam District. Madras Department of Agriculture Leaflet No. 57.	Ditto .	Ditto.
24	Note Book of Agricultural Facts and Figures. (English, 4th Edition.)	R. Cecil Wood . .	Ditto.
25	Madras Agricultural Department's Year Book, 1928.	Issued by the Department of Agriculture, Madras.	Ditto.
26	Villagers' Calendar (Madras) for 1929-30.	Ditto . .	Ditto.
27	Annual Report of the Department of Agriculture in the Bombay Presidency for the year 1927-28. Price, As. 11.	T. F. Main, O.B.E. .	Government Central Press, Bombay.
28	Proceedings of the Bombay Provincial Board of Agriculture held at Poona on the 25th and 26th August, 1925. Price, Re. 1-3.	Issued by the Department of Agriculture, Bombay.	Ditto.
29	Proceedings of the Bombay Provincial Board of Agriculture held at Poona on the 26th and 27th September, 1927. Price, As. 4.	Ditto .	Ditto.
30	Field, Garden and Orchard Crops of the Bombay Presidency. Bombay Department of Agriculture Bulletin No. 30 of 1908. (Revised and enlarged edition, 1928.)	G. B. Patwardhan .	Ditto.

List of Agricultural Publications in India during 1928-29—contd.

No.	Title	Author	Where published
	GENERAL AGRICULTURE —*contd.*		
31	Jowars of the Bombay Karnatak. Selection in —. Bombay Department of Agriculture Bulletin No. 151. Price, As. 6.	G. L. Kottur and V. M. Chavan.	Government Central Press, Bombay.
32	Agriculture in Sind under the Barrage Canals System. Bombay Department of Agriculture Bulletin No. 159 of 1929. Price, As. 6.	T. F. Main, O.B.E.	Ditto.
33	Rice Variety (Kolamba No. 42): What it is and where to get it. Bombay Department of Agriculture Leaflet No. 5 of 1928.	Issued by the Department of Agriculture, Bombay.	Ditto.
34	Poudrette and Town-sweepings as Manures for dry crops of Jowar and Cotton in the Transition Tract of the Karnatak. Bombay Department of Agriculture Leaflet No. 10 of 1928.	Ditto	Ditto.
35	Tobacco in Gujarat. Bombay Department of Agriculture Leaflet No. 1 of 1929.	Ditto	Ditto.
36	Sugarcane Crushing. Bombay Department of Agriculture Leaflet No. 3 of 1929.	Ditto	Ditto.
37	Annual Report of the Department of Agriculture, Bengal, 1927-28. Price, Rs. 6-10 or 10*s.* 9*d.*	R. S. Finlow, C.I.E.	Bengal Secretariat Book Depot.
38	Tomato. Cultivation of —. Bengal Department of Agriculture Leaflet No. 4 of 1928.	Issued by the Department of Agriculture, Bengal.	Sreenath Press, Dacca.
39	Flax. Cultivation of — on Rungpur Demonstration Farm. Bengal Department of Agriculture Leaflet No. 5 of 1928.	Ditto	Ditto.
40	Annual Report of the Department of Agriculture, Bihar and Orissa, for 1927-28.	B. C. Burt, M.B.E.	Government Printing Bihar and Orissa, Gulzarbagh.
41	Combined Farm Reports of the Department of Agriculture, Bihar and Orissa, for 1927-28.	Issued by the Department of Agriculture, Bihar and Orissa.	Ditto.

List of Agricultural Publications in India during 1928-29—contd.

No.	Title	Author	Where published
	GENERAL AGRICULTURE —*contd.*		
42	Maize. Leaflet of the Bihar and Orissa Department of Agriculture.	Issued by the Department of Agriculture, Bihar and Orissa.	Government Printing, Bihar and Orissa, Gulzarbagh.
43	Groundnut. Leaflet of the Bihar and Orissa Department of Agriculture.	Ditto	Ditto.
44	Sugarcane in North Bihar. Leaflet of the Bihar and Orissa Department of Agriculture.	Ditto	Ditto.
45	Sugarcane in South Bihar Range. Leaflet of the Bihar and Orissa Department of Agriculture.	Ditto	Ditto.
46	Improved Paddies for Orissa. Leaflet of the Bihar and Orissa Department of Agriculture.	Ditto	Ditto.
47	Varieties of Paddies which have been found suitable for growing in South-East Bihar Range. Leaflet of the Bihar and Orissa Department of Agriculture.	Ditto	Ditto.
48	Varieties of Wheat which have been found suitable for growing in South-East Bihar Range. Leaflet of the Bihar and Orissa Department of Agriculture.	Ditto	Ditto.
49	Ammophos. Leaflet of the Bihar and Orissa Department of Agriculture.	Ditto	Ditto.
50	Gypsum. Leaflet of the Bihar and Orissa Department of Agriculture.	Ditto	Ditto.
51	Simple Agricultural Implements, their use and care. Leaflet of the Bihar and Orissa Department of Agriculture.	Ditto	Ditto.
52	The Bihar 5-tined Cultivator. Leaflet of the Bihar and Orissa Department of Agriculture.	Ditto	Ditto.

List of Agricultural Publications in India during 1928-29—contd.

No.	Title	Author	Where published
	GENERAL AGRICULTURE —*contd.*		
53	The Mowing Machine and its use. Leaflet of the Bihar and Orissa Department of Agriculture.	Issued by the Department of Agriculture, Bihar and Orissa.	Government Printing, Bihar and Orissa, Gulzarbagh.
54	Suitable implements and better methods of cultivating heavy black soils of South Bihar. Leaflet of the Bihar and Orissa Department of Agriculture.	Ditto .	Ditto
55	Well boring notice. Leaflet of the Bihar and Orissa Department of Agriculture.	Ditto .	Ditto.
56	The care and maintenance of 2½" open borings. Leaflet of the Bihar and Orissa Department of Agriculture.	Ditto .	Ditto.
57	Report on the Administration of the Department of Agriculture, United Provinces, for the year ending 30th June, 1928. Price, Rs. 2.	G. Clarke, C.I.E. . .	Government Press, Allahabad.
58	Report on the Agricultural Stations of the Central Circle, Cawnpore, for the year 1927-28. Price, As. 15.	T. R. Low . . .	Ditto.
59	Report on the Agricultural Stations of the Western Circle, United Provinces, for the year ending May 31, 1928. Price, As. 10.	A. E. Parr . . .	Ditto.
60	Combined Report on the Experimental Station and District Demonstration Farms, in the Eastern Circle, Partabgarh, United Provinces, for the year ending 31st May, 1928. Price, Rs. 1-4.	L. C. Sharma . .	Ditto.
61	Report on the Agricultural Stations of North-Eastern Circle, United Provinces, for the year 1927-28. Price, Re. 1-4.	Lala Harbhajan Lal Sahib	Ditto.
62	Report on the Agricultural Stations of the Rohilkhand Circle, Shahjahanpur, United Provinces, for the year ending 31st May, 1928. Price, As. 14.	Khan Sahib Muhammad Naib Hussain.	Ditto.

List of Agricultural Publications in India during 1928-29—contd.

No.	Title	Author	Where published
	GENERAL AGRICULTURE —*contd.*		
63	Report on the Agricultural Stations of the Bundelkhand Circle, Jhansi, United Provinces, for the year 1927-28. Price, As. 12.	Nand Kishore Sharma .	Government Press, Allahabad.
64	Report on the Agricultural Stations in Hill Circle, Jeolikote, Naini Tal, United Provinces, for the year 1927-28. Price, As. 4.	S. D. Joshi . . .	Ditto.
65	Report on the Preliminary Agricultural Survey of the Almora District, United Provinces.	Ditto . . .	Ditto.
66	Cultivation of Broom Corn .	S. S. Nehru . .	Ditto.
67	Report on the Operations of the Department of Agriculture, Punjab, for 1926-27. Part II, Vol. I. Price, Rs. 4-8.	Issued by the Department of Agriculture, Punjab.	Government Printing, Lahore.
68	Report on the Operations of the Department of Agriculture, Punjab, for 1926-27. Part II, Vol. II. Price, Rs. 11-8.	Ditto . .	Ditto.
69	Report on the Operations of the Department of Agriculture, Punjab, for the year ending 30th June, 1928. Part I. Price, Re. 1-4 or 1*s.* 11*d.*	D. Milne, C.I.E. . .	Ditto.
70	Report on the Operations of the Department of Agriculture, Punjab, for the year ending 30th June, 1928. Part II, Vol. II. Price, Rs. 6-12.	Issued by the Department of Agriculture, Punjab.	Ditto.
71	Ten Commandments from the Goddess of Agriculture. Punjab Department of Agriculture Leaflet No. 67.	Ditto .	Ditto.
72	Selection of Plants. Punjab Department of Agriculture Leaflet No. 68.	Ditto .	Ditto.
73	Annual Report on the Operations of the Department of Agriculture, Burma, for the year ending 30th June, 1928.	A. McKerral . .	Government Printing, Burma, Rangoon.

List of Agricultural Publications in India during 1928-29—contd.

No.	Title	Author	Where published
	GENERAL AGRICLUTURE —*contd.*		
74	Annual Report of the Principal, Agricultural College and Research Institute, Burma, Mandalay, for the year ending 30th June, 1928. Price, As. 4 or 5*d.*	J. Charlton . . .	Government Printing, Burma, Rangoon.
75	Report on the Hmawbi Agricultural Station, for the year ending 30th June, 1928. Price, Re. 1-4 or 1*s.* 11*d.*	D. Hendry . . .	Ditto.
76	Report on the Mudon Agricultural Station, for the year ending 30th June, 1928. Price, As. 6 or 7*d.*	W. Gregson . .	Ditto.
77	Report on the Mahlaing Experimental Station, for the year ending 30th June, 1928. Price, Re. 1 or 1*s.* 6*d.*	T. D. Stock . .	Ditto.
78	Report on the Pwinbyu Seed Farm, for the year ending 30th June, 1928. Price, As. 4 or 5*d.*	F. D. Odell . .	Ditto.
79	Report on the Pyinmana Agricultural Station for the year ending 30th June, 1928. Price, As. 12 or 1*s.* 1*d.*	A. McLean . . .	Ditto.
80	Report on the Yaunghwe Agricultural Station and Agricultural work in the Southern Shan States, for the year ending 30th June, 1928. Price, As. 8 or 9*d.*	....	Ditto.
81	The combined report on the Akyab Agricultural Station and Kyaukpyau coconut farm the year ending 30th June, 1928. Price, As. 12 or 1*s.* 1*d.*	R. Watson . . .	Ditto.
82	Report on the Myaungmya Agricultural Station, for the year ending 30th June, 1928. Price, As. 6 or 7*d.*	R. A. Beale . .	Ditto.
83	Report on the Padu Agricultural Station, for the year ending 30th June, 1928. Price, As. 12 or 1*s.* 1*d.*	H. F. Robertson . .	Ditto.

List of Agricultural Publications in India during 1928-29—contd.

No.	Title	Author	Where published
	GENERAL AGRICULTURE —*contd.*		
84	Report on the Allanmyo Agricultural Station, for the year ending 30th June, 1928. Price, As. 10 or 11*d.*	F. D. Odell . .	Government Printing, Burma, Rangoon.
85	Report on the Mandalay Agricultural College Farm, for the year ending 30th June, 1928. Price, Re. 1 or 1*s.* 6*d.*	W. M. Clark . .	Ditto.
86	Report on the Tatkon Agricultural Station, for the year ending 30th June, 1928. Price, As. 12 or 1*s.* 1*d.*	A. McLean . . .	Ditto.
87	Report on the Sa-aing Sub-station, for the year ending 30th June, 1928. Price, As. 2 or 2*d.*	F. D. Odell . .	Ditto.
88	Report of the Agricultural Engineer, Burma, for the year ending 30th June, 1928. Price, As. 2 or 2*d.*	J. Charlton . . .	Ditto.
89	Fertilizers for Paddy. Results obtained at the Hmawbi Agricultural Station. Burma Department of Agriculture Bulletin No. 25 of 1928.	Issued by the Department of Agriculture, Burma.	Ditto.
90	The Marketing of Crops in Burma. Burma Agricultural Survey No. 5.	Ditto .	Ditto.
91	Coconut Survey on Coastal areas of the Arakan, Irrawaddy and Tenasserim Divisions. Burma Agricultural Survey No. 6.	Ditto .	Ditto.
92	Tung Oil. Burma Cultivators' Leaflet No. 56.	Ditto .	Ditto.
93	Manuring of Paddy lands for increased yields. Burma Cultivators' Leaflet No. 57.	Ditto .	Ditto.
94	Paddy Improvement in Arakan. Burma Cultivators' Leaflet No. 58.	Ditto .	Ditto.
95	Small Pumping Sets for Irrigation Purposes. Burma Cultivators' Leaflet No. 59.	Ditto .	Ditto.

List of Agricultural Publications in India during 1928-29—contd.

No.	Title	Author	Where published
	GENERAL AGRICULTURE —*contd.*		
96	Improved Paddy. Varieties of —. for Insein, Pegu, Hanthawaddy, etc. Burma Cultivators' Leaflet No. 60.	Issued by the Department of Agriculture, Burma.	Government Printing, Burma, Rangoon.
97	Cotton. Drill Sowing of —. Burma Cultivators' Leaflet No. 61.	Ditto .	Ditto.
98	Agricultural Calendar, Burma .	Ditto .	Ditto.
99	Report on the working of the Department of Agriculture, Central Provinces, 1927-28.	F. J. Plymen . .	Government Press, Nagpur.
100	Quinquennial Review of Demonstration Work carried out in the Nimar District during the period from 1922-27. Price, As. 3.	Issued by the Department of Agriculture, Central Provinces and Berar.	Ditto.
101	Annual Report on the working of the Department of Agriculture, Assam, for 1927-28.	Issued by the Department of Agriculture, Assam.	Government Press, Shillong.
102	Potato. A Note of Warning to —. cultivators in the plains district. Assam Department of Agriculture Leaflet No. 5.	Ditto .	Ditto.
103	Sweet Potato. Assam Department of Agriculture Leaflet No. 2 of 1929.	S. K. Mitra and F. Ahmmad.	Ditto.
104	Report of the Agricultural Stations at Tarnab and Haripur in the North-West Frontier Province for the year 1927-28.	A. M. Mustafa . .	North-West Frontier Province Government Printing and Stationery, Peshawar.
105	Mysore Agricultural Calendar, 1929. Price, As. 2.	Issued by the Mysore Department of Agriculture.	Government Press, Bangalore.
106	Administration Report of the Department of Agriculture and Fisheries, Travancore, 1927-28.	N. Kunjan Pillai . .	Travancore State Press, Trivandrum.
107	Annual Report of the Department of Agriculture and Agricultural Engineering, Gwalior Government, 1927-28.	H. H. Pandya . .	Alijah Darbar Press, Lashkar.

List of Agricultural Publications in India during 1928-29—contd.

No.	Title	Author	Where published
	AGRICULTURAL STATISTICS.		
108	Agricultural Statistics of India, 1926-27. Vol. I. Price, Re. 1-4 or 2*s.* 3*d.*	Issued by the Department of Commercial Intelligence and Statistics, India.	Government of India Central Publication Branch, Calcutta.
109	Agricultural Statistics of India, 1926-27. Vol. II. Price, Re. 1-4 or 2*s.* 3*d.*	Ditto .	Ditto.
110	Estimates of Area and Yield of Principal Crops in India, 1927-28. Price, As. 14 or 1*s.* 6*d.*	Ditto .	Ditto.
111	Season and Crop Report of the Madras Presidency for Agricultural year 1927-28 (Fasli 1337). Price, Re. 1-4.	Issued by the Department of Agriculture, Madras.	Government Press, Madras.
112	Annual Season and Crop Report of the Bombay Presidency for the year 1927-28. Price, As 8 or 6*d.*	T. F. Main, O.B.E. .	Government Central Press, Bombay.
113	Season and Crop Report of Bengal for 1928-29. Price, Rs. 2-6 or 4*s.* 3*d.*	G. P. Hector . .	Bengal Secretariat Book Depot.
114	Monthly and Annual Rainfall Table in the province of Bengal for 1928.	Ditto .	Ditto.
115	Season and Crop Report of Bihar and Orissa, for 1928-29. Price, Rs. 2-4.	B. C. Burt, M.B.E. .	Government Printing, Bihar and Orissa, Gulzarbagh.
116	Agricultural Statistics of Bihar and Orissa, for 1927-28.	Ditto .	Ditto.
117	Season and Crop Report of the United Provinces of Agra and Oudh for the year 1927-28. Price, Re. 1-4.	The Director of Land Records, United Provinces (A. L. Mohendra).	Government Press, Allahabad.
118	Report on the Season and Crops of the Punjab for 1927-28. Price, Rs. 3-4 or 5*s.*	Officiating Director of Land Records, Punjab (Arjan Das).	Government Printing, Lahore.
119	Tables of Agricultural Statistics of the Punjab for 1927-28.	Ditto .	Ditto.
120	Punjab Cattle Census Report of 1928.	Issued by the Department of Agriculture, Punjab.	Ditto.

List of Agricultural Publications in India during 1928-29—contd.

No.	Title	Author	Where published
	AGRICULTURAL STATISTICS —*contd.*		
121	Season and Crop Report of Burma for the year ending 30th June, 1928. Price, Re. 1-8 or 2*s.* 3*d.*	The Commissioner of Settlements and Land Records, Burma. (H. O. Reynolds).	Government Printing and Stationery, Rangoon.
122	Season and Crop Report of the Central Provinces and Berar for the year 1927-28. Price, Rs. 3.	The Director of Land Records, Central Provinces (C. F. Waterfall).	Government Press, Nagpur.
123	Report on the Season and Crops of the North-West Frontier Province for the year 1927-28. Price, Re. 1-7 or 2*s.* 6*d.*	Revenue Commissioner, North-West Frontier Province (R. Garratt).	North-West Frontier Province Government Printing and Stationery, Peshawar.
124	Summary of Remarks on the Kharif crop of the North-West Frontier Province for 1928. Price, As. 10 or 1*s.*	Ditto	Ditto.
	FRUIT CULTURE.		
125	Grapevines. The Cultivation of —. Madras Department of Agriculture Bulletin No. 96. Price, As. 2.	Issued by the Department of Agriculture, Madras.	Government Press, Madras.
126	Plantains. Cultivation of —. on wet lands in the Godavari Delta. Madras Department of Agriculture Bulletin No. 93. Price, As. 2.	G. Jogi Raju	Ditto.
127	Economic Value of Fruit Farming in Western India. Bombay Department of Agriculture Bulletin No. 153 of 1928. Price, As. 6.	Dr. G. S. Cheema and P. G. Dani.	Government Central Press, Bombay.
128	Lemon Industry in Western India. A Preliminary Note on the possibilities of the Development of —. Bombay Department of Agriculture Bulletin No. 157 of 1929. Price, As. 2.	Ditto	Ditto.
129	Fruits. Home Canning of —. Bombay Department of Agriculture Leaflet No. 4 of 1928.	Issued by the Department of Agriculture, Bombay.	Aryabhushan Press, Poona City.
130	Fig Cultivation. Hints on —. Bombay Department of Agriculture Leaflet No. 4 of 1929.	Ditto	Ditto.

List of Agricultural Publications in India during 1928-29—contd.

No.	Title	Author	Where published
	FRUIT CULTURE—*contd.*		
131	Report on the Working and Administration of the United Provinces Gardens for the year 1927-28. Price, Re. 1-2.	A. E. P. Griessen .	Government Press, Allahabad.
132	Report on the Lawrence Gardens, Lahore, for 1927-28. Price, As. 6.	D. Milne, C.I.E. . .	Government Printing, Lahore.
133	Strawberries. Cultivation of —. Punjab Department of Agriculture Leaflet No. 61.	Issued by the Department of Agriculture, Punjab.	Ditto.
134	Orange Marmalade. How to make —. Punjab Department of Agriculture Leaflet No. 64.	Ditto .	Ditto.
135	Windbreaks. Punjab Department of Agriculture Leaflet No. 69.	Ditto .	Ditto.
136	Planting of Fruit Trees. Punjab Department of Agriculture Leaflet No. 70.	Ditto .	Ditto.
137	Orange Cultivation in Assam. Assam Department of Agriculture Bulletin No. 2 of 1928.	Issued by the Department of Agriculture, Assam.	Government Press, Shillong.
138	Banana Culture. Assam Department of Agriculture Leaflet No. 1 of 1929.	S. K. Mitra . .	Ditto.
	SERICULTURE.		
139	Sericulture in Bengal. Bengal Department of Agriculture Leaflet No. 6 of 1929.	Issued by the Bengal Department of Agriculture.	Bengal Secretariat Book Depot.
140	Report of the Sericultural Operations, Burma, for the year ending 30th June, 1928. Price, As. 4 or 5*d.*	C. C. Ghosh . .	Government Printing, Burma, Rangoon.
141	Report of work done in the Department of Sericulture in Mysore, during 1927-28.	H. S. Gobinda Rao .	Government Press, Bangalore.
	AGRICULTURAL CHEMISTRY.		
142	Soils of the Punjab. Memoirs of the Department of Agriculture in India, Chemical Series, Vol. X, No. 2. Price, Rs. 3-14 or 6*s.* 9*d.*	P. E. Lander . .	Government of India Central Publication Branch, Calcutta.

List of Agricultural Publications in India during 1928-29—contd.

No.	Title	Author	Where published
	AGRICULTURAL CHEMISTRY —*contd.*		
143	A Soil Survey of the Krishna Delta. Madras Department of Agriculture Bulletin No. 51 (Reprint). Price, Rs. 2-4.	W. H. Harrison and M. R. Ramaswami Sivan.	Government Press, Madras.
144	Soil Survey of the Malabar District. Madras Department of Agriculture Bulletin No. 91. Price, Re. 1-6.	B. Viswanath and T. S. Ramasubrahmanyam.	Ditto.
145	Field Experiments with Calcium Cyanamide as a Nitrogenous Manure for South Indian Soils and Crops. Madras Department of Agriculture Bulletin No. 94.	B. Viswanath and S. Kashinathan.	Ditto.
146	Assimilation of nutrients by the rice plant. Bombay Department of Agriculture Bulletin No. 154 of 1928. Price, As. 5.	Rao Bahadur D. L. Sahasrabudhe.	Government Central Press, Bombay.
147	A Study of the Soils associated with the deterioration of the Cardamom crop in North Canara. Bombay Department of Agriculture Bulletin No. 157 of 1929. Price, As. 3.	Ditto .	Ditto.
148	Report of the Agricultural Chemist, Burma, for the year ending 30th June, 1928. Price, As. 4 or 6*d.*	J. Charlton . . .	Government Printing, Burma, Rangoon.
	BOTANY.		
149	Studies in Indian Chillies, I. The Types of Capsicum. Memoirs of the Department of Agriculture in India, Botanical Series, Vol. XVI, No. 2. Price, Re. 1-8 or 2*s.* 6*d.*	F. J. F. Shaw . .	Government of India Central Publication Branch, Calcutta.
150	Further Studies of Indian Grasses and Grasslands. Memoirs of the Department of Agriculture in India, Botanical Series, Vol. XVI, No. 4. Price, Re. 1-4 or 2*s.* 3*d.*	W. Burns, L. B. Kulkarni and S. R. Godbole.	Ditto.
151	Studies of Sugarcane Roots at different stages of growth. Memoirs of the Department of Agriculture in India, Botanical Series, Vol. XVI, No. 5. Price As. 13 or 1*s.* 6*d.*	Rao Bahadur T. S. Venkatraman and R. Thomas.	Ditto.

List of Agricultural Publications in India during 1928-29—contd.

No.	Title	Author	Where published
	BOTANY—*contd.*		
152	Studies in Indian Pulses: I. Lentil (*Ervum lens*, Linn.). Memoirs of the Department of Agriculture in India, Botanical Series, Vol. XVI, No. 6. Price, Re. 1-10 or 2*s*. 6*d*.	F. J. F. Shaw and Rakhal Das Bose.	Government of India Central Publication Branch, Calcutta.
153	Non-dehiscence of Anthers in Punjab American Cottons. Memoirs of the Department of Agriculture in India, Botanical Series, Vol. XVII, No. I. Price, As. 4 or 5*d*.	Trevor Trought . .	Ditto.
154	The Production of Cigarette Tobacco by Flue-curing, Pusa Agricultural Research Institute Bulletin No. 187. Price, Re. 1 or 1*s*. 9*d*.	F. J. F. Shaw and Kashi Ram.	Ditto.
155	The Improvement of Dharwar-American Cotton by Hybridization. Pusa Agricultural Research Institute Bulletin No. 189. Price, Rs. 2-2 or 4*s*.	R. K. Kulkarni and T. R. Khandikar.	Ditto.
156	Report of the Economic Botanist, Burma, for the year ending 30th June, 1928. As. 4 or 5*d*.	D. Rhind . . .	Government Printing, Burma, Rangoon.
	MYCOLOGY.		
157	Foot-rot and Wilt of Antirrhinums caused by *Phytophthorapini* var. *antirrhini*, n. v. Memoirs of the Department of Agriculture in India, Botanical Series, Vol. XVI, No. 3. Price, Re. 1 or 1*s*. 9*d*.	S. Sundararaman and T. S. Ramakrishnan.	Government of India Central Publication Branch, Calcutta.
158	*Pythium aphanidermatum* (Eds.) Fitz on *Opuntia Dillenii*, Haw. Memoirs of the Department of Agriculture in India, Botanical Series, Vol. XVI, No. 7. Price, As. 8 or 10*d*.	T. S. Ramakrishnan .	Ditto.
159	Studies in the Wilt Disease of cotton in the Bombay Karnatak, Series I; with an Introduction by Dr. Harold H. Mann. Memoirs of the Department of Agriculture in India, Botanical Series, Vol. XVII, No. 2. Price, As. 9 or 1*s*.	G. S. Kulkarni and B. B. Mundkur.	Ditto.

List of Agricultural Publications in India during 1928-29—contd.

No.	Title	Author	Where published
	MYCOLOGY—*contd.*		
160	A Leaf Spot and Blight Disease of Onions caused by *Alternaria palandui*, nov. sp. Pusa Agricultural Research Institute Bulletin No. 179. Price, As. 6 or 8*d*.	C. Rangaswami Ayyangar	Government of India Central Publication Branch, Calcutta.
161	Some Diseases of Crops in the Andaman Islands. Pusa Agricultural Research Institute Bulletin No. 195. Price, As. 4 or 5*d*.	M. Mitra . . .	Ditto.
162	Mosaic Disease of Sugarcane. Madras Department of Agriculture Bulletin No. 92. Price, As. 6.	S. Sundararaman . .	Government Press, Madras.
163	Coconut Stem Bleeding Disease. Madras Department of Agriculture Leaflet No. 15 (Revised).	S. Sundararaman . .	Ditto.
164	Treatment of Smut by Copper Sulphate. Madras Department of Agriculture Leaflet No. 26 (Reprint).	Subbanachar . .	Ditto.
165	Red-rot Disease of Sugarcane. Madras Department of Agriculture Leaflet No. 51.	Issued by the Department of Agriculture, Madras.	Ditto.
166	Die-Back disease of Citrus trees and its relation to the Soils of Western India. Bombay Department of Agriculture Bulletin No. 155 of 1928. Price, As. 5.	G. S. Cheema and S. S. Bhat.	Government Central Press, Bombay.
167	Control of the Powdery Mildew of Grape. Bombay Department of Agriculture Leaflet No. 6 of 1928.	Issued by the Department of Agriculture, Bombay.	Ditto.
168	Control of the Red-Rot of Sugarcane. Bombay Department of Agriculture Leaflet No. 7 of 1928.	Ditto . .	Ditto.
169	Potato Blight. Leaflet of the Bengal Department of Agriculture.	Issued by the Department of Agriculture, Bengal.	Sreenath Press, Dacca.
170	A Note on the Control of Sugarcane Mosaic.	P. K. Dey . . .	Government Press, Allahabad.

List of Agricultural Publications in India during 1928-29—contd.

No.	Title	Author	Where published
	MYCOLOGY—*concld.*		
171	*Jowar.* A root parasite of Sugarcane and —. Punjab Department of Agriculture Leaflet No. 63.	Issued by the Department of Agriculture, Punjab.	Government Printing Lahore.
172	Report of the Mycologist, Burma, for the year ending 30th June, 1928. As. 4 or 5*d.*	H. F. Robertson . .	Government Printing, Burma, Rangoon.
173	Betel Vine Disease. Assam Department of Agriculture Leaflet No. 4.	Issued by the Department of Agriculture, Assam.	Government Press, Shillong.
174	Areca palm disease. Remedy for —. Assam Department of Agriculture Leaflet No. 6.	Ditto .	Ditto.
	ENTOMOLOGY.		
175	A Contribution to our knowledge of the Thysanoptera of India. Memoirs of the Department of Agriculture in India, Entomological Series. Vol. X, No. 7. Price, Re. 1-9 or 2*s.* 6*d.*	T. V. Ramakrishna Ayyar	Government of India Central Publication Branch, Calcutta.
176	A List of Generic Names used for Microlepidoptera. Memoirs of the Department of Agriculture in India, Entomological Series, Vol. XI. Price, Rs. 3 or 5*s.* 3*d.*	T. Bainbrigge Fletcher	Ditto.
177	Life History, Bionomics and Control of *Myllocerus maculosus*, Desb. (Curculionidæ: Coleoptera). Pusa Agricultural Research Institute Bulletin No. 181. Price, As. 14 or 1*s.* 6*d.*	Kidar Nath Trihan .	Ditto.
178	The Cultivation of Lac in the Plains of India, *Laccifera Lacca*, Kerr. Pusa Agricultural Research Institute Bulletin No. 185. Price, Rs. 4 or 6*s.* 9*d.*	Rai Bahadur C. S. Misra	Ditto.
179	The Cotton White-Fly (*Bemesia gossypiperda* n. sp.). Pusa Agricultural Research Institute Bulletin No. 196. Price, As 10 or 1*s.*	Rai Bahadur C. S. Misra and Karam Singh Lamba.	Ditto.

List of Agricultural Publications in India during 1928-29—contd.

No.	Title	Author	Where published
	ENTOMOLOGY—*contd.*		
180	Blue Beetle of Paddy—*Leptispa pygmæa*—a serious pest of the Paddy Crop in Malabar. Madras Department of Agriculture Leaflet No. 55.	Issued by the Department of Agriculture, Madras.	Government Press, Madras.
181	Lac—a paying crop for the submontane tracts. Punjab Department of Agriculture Leaflet No. 62.	Issued by the Department of Agriculture, Punjab.	Government Press, Lahore.
182	Annual Report of the Entomologist, Burma, for the year ending 30th June, 1928. Price, As. 4 or 5*d.*	C. C. Ghosh . .	Government Printing, Burma, Rangoon.
	BACTERIOLOGY.		
183	Nitrification of calcium cyanamide in some Indian soils. Memoirs of the Department of Agriculture in India, Bacteriological Series, Vol. II, No. 3. Price, As. 10 or 1*s.*	J. H. Walton . .	Government of India Central Publication Branch, Calcutta.
	ANIMAL HUSBANDRY AND DAIRYING.		
184	*The Journal of the Central Bureau for Animal Husbandry and Dairying in India*, Vol. II, Parts II, III and VI, and Vol. III, Part I. Price, As. 10 per part or Rs. 2-8 per annum.	The Agricultural Adviser to the Government of India (Editor).	Ditto.
185	The Work of the Livestock Section. Madras Department of Agriculture Bulletin No. 95.	R. W. Littlewood .	Government Press, Madras.
186	Conditions to be fulfilled for the grant of Government Premium for Breeding Bulls maintained by Private Bodies (English). Madras Department of Agriculture Leaflet No. 54.	Issued by the Madras Department of Agriculture.	Ditto.
187	Rations for Cattle when Fodder is scarce. Bombay Department of Agriculture Leaflet No. 8 of 1928.	Issued by the Department of Agriculture, Bombay.	Government Central Press, Bombay.

List of Agricultural Publications in India during 1928-29—contd.

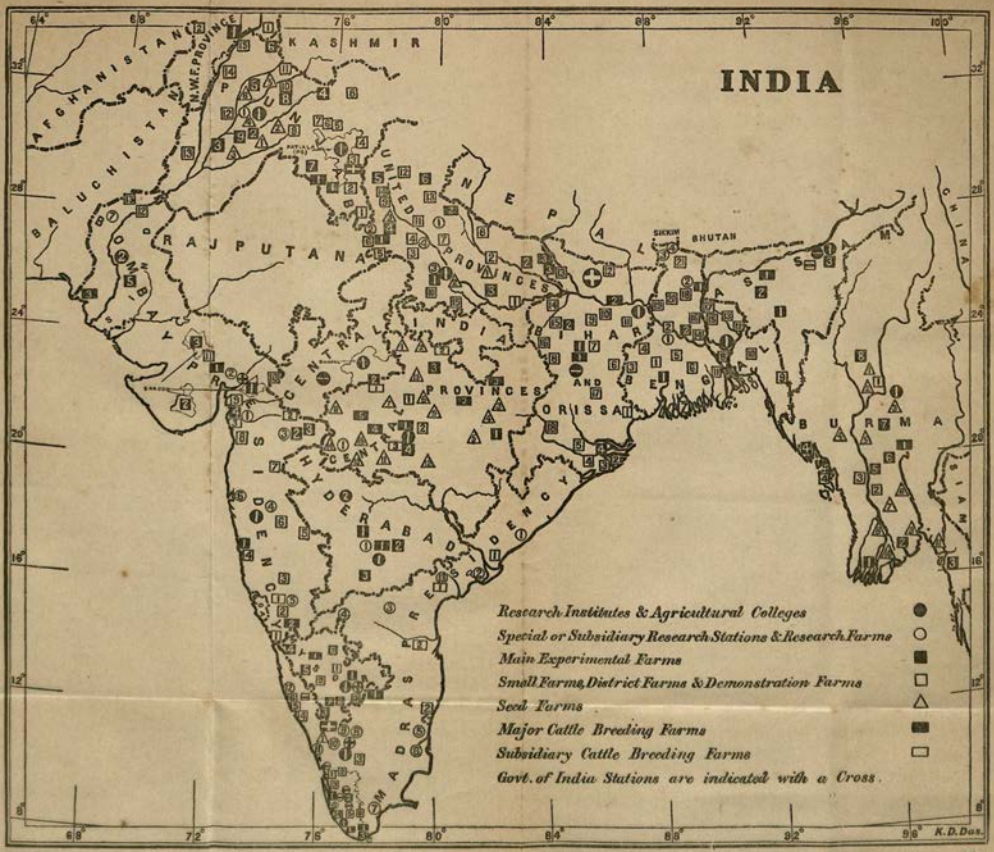
No.	Title	Author	Where published
	ANIMAL HUSBANDRY AND DAIRYING—*contd.*		
188	Hay, its making, and the use of the Mowing Machine. Bombay Department of Agriculture Leaflet No. 9 of 1928.	Issued by the Department of Agriculture, Bombay.	Government Central Press, Bombay.
189	Livestock Section Extension Service—The Tick-proof Perch. Bombay Department of Agriculture Leaflet No. 11 of 1928.	Ditto	Ditto.
190	Livestock and Dairy Section Service—Clean Milk and how to produce it. Bombay Department of Agriculture Leaflet No. 12 of 1928.	Ditto	Ditto.
191	Prickly-pear as Fodder. Bombay Department of Agriculture Leaflet No. 2 of 1929.	Ditto	Ditto.
192	Guinea grass. Bombay Department of Agriculture Leaflet No. 5 of 1929.	Ditto	Ditto.
193	Cattle Improvement and Cultivation of Fodder Crops in Orissa. Bihar and Orissa Department of Agriculture Bulletin No. 1 of 1928.	Issued by the Department of Agriculture, Bihar and Orissa.	Government Printing Bihar and Orissa, Gulzarbagh.
194	Ensilage. Leaflet of the Bihar and Orissa Department of Agriculture.	Ditto	Ditto.
195	Dictionary of Poultry Terms. Punjab Department of Agriculture Leaflet No. 65.	Issued by the Department of Agriculture, Punjab.	Government Printing, Punjab, Lahore.
196	Berseem as a new crop for the Province. Punjab Department of Agriculture Leaflet No. 66.	Ditto	Ditto.
197	A simple method of identifying the best laying hens. Punjab Department of Agriculture Leaflet No. 71.	Ditto	Ditto.
198	The Supply of Plough Cattle in Burma. Burma Department of Agricultural Survey No. 7 of 1928.	Issued by the Department of Agriculture, Burma.	Government Printing, Burma, Rangoon.
199	Report on the working of the Amrit Mahal Department, Mysore, 1927-28.	A. A. Monteiro	Government Press, Bangalore.

List of Agricultural Publications in India during 1928-29—contd.

No.	Title	Author	Where published
	VETERINARY.		
200	*The Indian Veterinary Journal* (Quarterly). Annual Subscription, Rs. 4 for members of All-India Veterinary Association and Students, Rs. 8 for others.	P. Sirinivasa Rao (Editor)	Methodist Publishing House, Madras.
201	Report of the Imperial Institute of Veterinary Research, Muktesar, for the year ending 31st March, 1928. Price, Re. 1-6 or 2*s.* 3*d.*	J. T. Edwards . .	Government of India Central Publication Branch, Calcutta.
202	Nasal Granuloma of Cattle in Bihar and Orissa (Experiments regarding mode of infection and treatment). Memoirs of the Department of Agriculture in India, Veterinary Series, Vol. IV, No. 4, Price, As. 3 or 4*d.*	Rai Saheb P. N. Das .	Ditto.
203	Description of a New Species *Dipylidium catus* n. sp., with a note on the Genus *Dipylidium* Leuckart, 1863. Pusa Agricultural Research Institute Bulletin No. 190. Price, As. 6 or 8*d.*	Amarnath Gulati . .	Ditto.
204	Annual Administration Report of the Civil Veterinary Department, Madras, for 1927-28.	F. Ware	Government Press, Madras.
205	Annual Administration Report of the Bombay Veterinary College, Bombay City and Harbour Veterinary Department and Civil Veterinary Department in the Bombay Presidency (including Sind) for 1927-28. Price, As. 4 or 5*d.*	K. Hewlett, E. S. Farbrother and J. H. G. Jerrom.	Government Central Press, Bombay.
206	Annual Report of the Civil Veterinary Department, Bengal, and Bengal Veterinary College for the year 1927-28.	R. T. Davis . . .	Bengal Secretariat Book Depot.
207	Annual Report of the Civil Veterinary Department, Bihar and Orissa, for 1927-28. Price, Re. 1.	P. B. Riley . .	Government Printing, Bihar and Orissa, Gulzarbagh.

List of Agricultural Publications in India during 1928-29—concld.

No.	Title	Author	Where published
	VETERINARY—*contd.*		
208	Annual Report of the Civil Veterinary Department, United Provinces, for the year ending 31st March, 1928. Price, Re. 1-2.	S. G. M. Hickey . .	Government Press, United Provinces, Allahabad.
209	Annual Report of the Punjab Veterinary College, Civil Veterinary Department, Punjab, and the Government Cattle Farm, Hissar, for the year 1927-28. Price, Rs. 5-8 or 8*s.* 3*d.*	W. Taylor, T. F. Quirke and R. Branford.	Government Printing, Punjab, Lahore.
210	Report on the work performed by the Officer in charge of the Camel Specialist's Office, Sohawa, for 1927-28.	Ch. Kahan Singh .	Ditto.
211	Annual Report of the Civil Veterinary Department, Burma, for the year ended 31st March, 1928. Price, Re. 1-4 or 1*s.* 11*d.*	A. McKerral . .	Government Printing, Burma, Rangoon.
212	Anthrax. Bulletin of the Burma Civil Veterinary Department.	D. T. Mitchell . .	Ditto.
213	Blood Smears. Bulletin of the Burma Civil Veterinary Department.	Ditto . . .	Ditto.
214	Black Quarter. Bulletin of the Burma Civil Veterinary Department.	Ditto . . .	Ditto.
215	Lymphangitis in Horses. Bulletin of the Burma Civil Veterinary Department.	Ditto . . .	Ditto.
216	Parasitic Worms of Domestic Animals. Bulletin of the Burma Civil Veterinary Department.	Ditto . . .	Ditto.
217	Report of the Civil Veterinary Department of the Central Provinces and Berar during the year 1927-28. Price, Re. 1-4.	R. F. Stirling . .	Government Press, Central Provinces, Nagpur.
218	Report of the Civil Veterinary Department, Assam, for 1927-28. Price, As. 6 or 7*d.*	W. Harris . . .	Assam Secretariat Printing Office, Shillong.
219	Annual Administration Report of the Civil Veterinary Department, North-West Frontier Province, for 1927-28. Price, Rs. 2-15 or 5*s.* 3*d.*	S. M. A. Shah . .	North-West Frontier Province Government Press, Peshawar.



Key to this Map is given on page 249.

APPENDIX XIV.

Key to the Diagrammatic Map of Agricultural Stations.

Research Institutes and Agricultural Colleges.

Imperial.
Pusa (Bihar and Orissa)

Madras.
1. Coimbatore.

Bombay.
1. Poona.
2. Sakrand.

Bengal.
1. Dacca.

United Provinces.
1. Cawnpore.

Punjab.
1. Lyallpur.

Burma.
1. Mandalay.

Bihar and Orissa.
1. Sabour.

Central Provinces.
1. Nagpur.

Assam.
1. Jorhat.

Special or Subsidiary Research Stations and Research Farms.

Imperial.
Bangalore (Mysore).
Coimbatore (Madras).
Anand (Bombay).

Madras.
1. Anakapalle.
2. Maruteru.
3. Nandyal.
4. Hagari.
5. Palur.
6. Adutural.
7. Koilpatti.
8. Burliar.
9. Coonoor.
10. Kallar.
11. Pattambi.
12. Kasargod.
13. Guntur.

Bombay.
1. Surat.
2. Nadiad.
3. Dhulia.
4. Manjri.
5. Dharwar.
6. Karjat.
7. Larkana.

Bengal.
1. Berhamporo.
2. Rangpur.
3. Kurseong.
4. Kalimpong.

United Provinces.
1. Shahjahanpore.
2. Muttra.
3. Cawnpore.
4. Farrukhabad.

Punjab.
1. Risalewala.

Central Provinces.
1. Akola.

Main Experimental Farms.

Bombay.
1. Ratnagiri.
2. Dhulia.
3. Jalgaon.
4. Surat.
5. Mirpurkhas.

Bengal.
1. Chinsura.
2. Rajshahi.

United Provinces.
1. Cawnpore.
2. Gorakhpore.
3. Partabgarh.
4. Aligarh.
5. Muzaffarnagar.
6. Jeollkote.

Punjab.
1. Hansi.
2. Montgomery.
3. Multan.
4. Gurdaspur.
5. Sargodha.
6. Rawalpindi.
7. Sirsa.
8. Kala Shah Kaku.
9. Harappa Road.

Burma.
1. Maungmya.
2. Hmawbi.
3. Mudon.
4. Akyab.
5. Allanmyo.
6. Pyinmana.
7. Mahlaing.
8. Kanbalu.

Bihar and Orissa.
1. Kanke.
2. Gaya.
3. Sepaya.
4. Cuttack.

Small Farms, District Farms and Demonstration Farms.

Madras.
1. Samalkota.
2. Palakuppam.
3. Vellalore.
4. Taliparamba.
5. Pillicode.
6. Nileshwar.

Bombay.
1. Kumta.
2. Mugad.
3. Gokak Canal.
4. Hatkhamba.
5. Mohol.
6. Baramati.
7. Kopargaon.
8. Amalsad.
9. Broach.
10. Bohad.
11. Viramgam.
12. Sukkur.
13. Jacobabad.

Bengal.
1. Burdwan.
2. Berhampore.
3. Bankura.
4. Suri.
5. Krishnagar.
6. Jessore.
7. Gosaba.
8. Faridpur.
9. Rangamati.
10. Comilla.
11. Barisal.
12. Kishoreganj.
13. Mymensingh.
14. Pabna.
15. Dhanbari.
16. Bogra.
17. Jamalpur.
18. Rangpur.
19. Malda.
20. Dinajpur.
21. Mainaguri.

Seed Farms.

Madras.
1. Nanjanad.

United Provinces.
1. Naugawan.
2. Kalianpur.
3. Kalai.

Punjab.
1. Fatna.
2. Shergarh.
3. Vihari.
4. Risalewala.
5. Chillianwala.
6. Sargodha.

Burma.
1. Shwebo (Chiba).
2. Kyehmon.
3. Singaing.
4. Pwinbyu.
5. Magwe.
6. Pyu.
7. Paungde.
8. Henzada.
9. Pegu.
10. Maubin.
11. Thaton.

Central Provinces.
1. Saugor.
2. Damoh.
3. Bilaspur.
4. Chandkhuri.
5. Drug.
6. Seoni.
7. Betul.
8. Khandwa.
9. Wara-Seoni.
10. Basim.
11. Yeotmal.
12. Sindewahi.
13. Narsinghpur.
14. Buldana.
15. Borgaon.

Major Cattle-breeding Farms.

Imperial.
Wellington (Madras).
Karnal (Punjab).

Madras.
Hosur.

Bombay.
1. Chharodi.
2. Bankapur.
3. Karachi.

Bengal.
Rangpur.

United Provinces.
1. Muttra.
2. Khari.

Punjab.
Hissar.

Burma.
Tatkon.

Bihar and Orissa.
1. Kanke.
2. Monghyr.
3. Sepaya.

Central Provinces.
1. Telinkheri.
2. Raigarh (Garhi).
3. Pendra.
4. Ellichpur.
5. Bod.

Assam.
Khanpara.

Subsidiary Cattle-breeding Farms.

Madras.
1. Guntur.
2. Chintaladevi.

Bombay.
1. Tegur.
2. Sangvi.
3. Surat.

Central Provinces.
1. Powarkhera.
2. Richal.
3. Nagpur College Dairy Farm.

Key to the Diagrammatic Map of Agricultural Stations—contd.

Research Institute and Agricultural Colleges.	Special or Subsidiary Research Stations and Research Farms.	Main Experimental Farms.	Small Farms, District Farms and Demonstration Farms.	Seed Farms.	Major Cattle-breeding Farms.	Subsidiary Cattle-breeding Farms.
		Central Provinces. 1. Raipur. 2. Powarkhera. 3. Adhartal. 4. Nagpur. *Assam.* 1. Karimganj. 2. Upper Shillong. 3. Titabor. *N.-W. F. Province.* 1. Tarnab.	*United Provinces.* 1. Benares. 2. Fyzabad. 3. Etawah. 4. Mainpuri. 5. Bichpuri. 6. Jachonda. 7. Hardoi. 8. Bahraich. 9. Bulandshahr. 10. Jaitpur. 11. Budaun. 12. Nagina. 13. Nawabganj. 14. Meerut. 15. Atarra. *Punjab.* 1. Gurgaon. 2. Rohtak. 3. Karnal. 4. Ambala. 5. Ludhiana. 6. Jullundar. 7. Beas. 8. Kangra. 9. Ferozepur. 10. Gujranwala. 11. Gujrat. 12. Jhang. 13. Dera Ghazi Khan. 14. Mianwali. 15. Campbellpur. *Burma.* 1. Padu. 2. Paukkaung. 3. Sa-aing. 4. Kyaukpyu. *Bihar and Orissa.* 1. Balasore. 2. Anandpur. 3. Puri. 4. Khurda. 5. Angul. 6. Purulia.			

Hyderabad.
1. Himayat Sagar.
2. Parbhani.

Mysore State.
1. Bangalore.

Travancore State.
1. Quilon.

Bhopal State.
1. Nabi Bagh.

Patiala State.
1. Patiala.

Non-official.
Indore (Central India—Institute of Plant Industry).
Ranchi (Bihar and Orissa—Lac Research Institute).

Tocklai (Assam-Indian Tea Association).

Hyderabad State.
1. Nizamsagar.

Travancore State.
1. Peerkad.

Non-official.
Mooply (Cochin—U. P. A. S. I.).
Peermade (Travancore—U. P. A. S. I.).
Aneikulam (Travancore—U. P. A. S. I.).
Tenmalai (Travancore—U. P. A. S. I.).

Hyderabad State.
1. Sangareddy.
2. Alir.
3. Mahbubnagar.

Mysore State.
1. Hebbal.
2. Naggenhalli.
3. Hansur.
4. Murthur.
5. Balehonnur.
6. Babbur.
7. Yellachihalli.

Baroda State.
1. Baroda.
2. Jagudan.
3. Amreli.

Travancore State.
1. Alleppey.
2. Koni.
3. Nagercoil.

Non-official.
Sidapur (Madras—U. P. A. S. I.).

7. Ramgarh.
8. Neterhat.
9. Nawadah.
10. Jamui.
11. Banka.
12. Darbhanga.
13. Siwan.
14. Bikramgunj.
15. Siris.
16. Chianki.
17. Chaibassa.
18. Sambalpur.

Central Provinces.
1. Chhindwara.
2. Tharsa.

N.-W. F. Province.
1. Haripur.
2. Parachinar.

Mysore State.
1. Chickanhalli.
2. Hassan.
3. Ramkrishnapur.

Travancore State.
1. Alwaye.
2. Cochira.
3. Vaikom.
4. Kottarakara.
5. Eraniel.
6. Puliyara.
7. Cape Comorin.

Non-official.
Borbhetta (Assam-Indian Tea Association).

Hyderabad State.
1. Hyderabad.

Mysore State.
1. Parvatharayanakere.

Travancore State.
1. Trivandrum.
1. Esanthimangalam.

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